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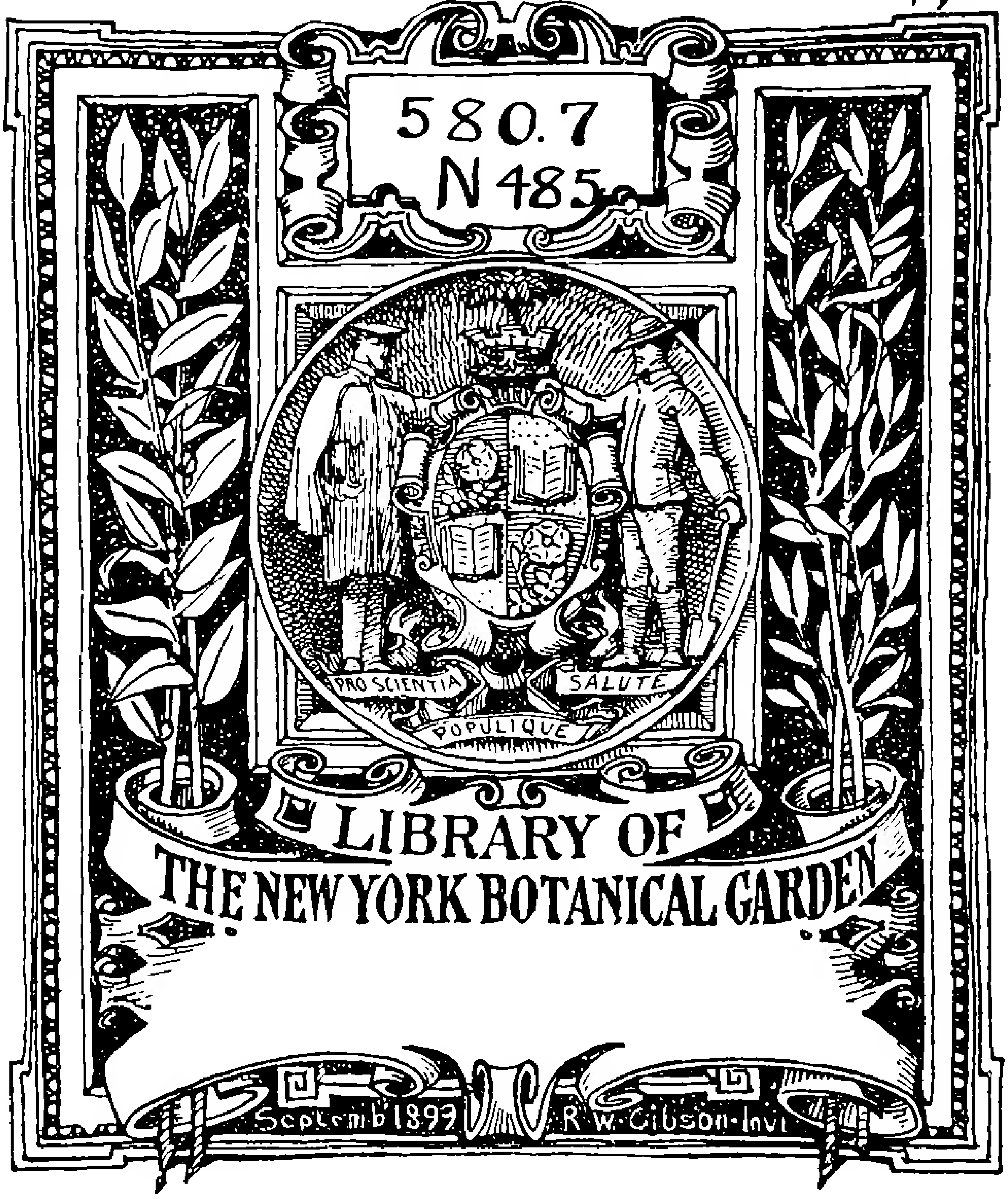

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BULLETIN

OF

THE NEW YORK BOTANICAL GARDEN

VOLUME VII, 1909–1911

BULLETIN

OF

The New York Botanical Garden

VOLUME VII.

WITH 51 PLATES

1909-1911

PUBLISHED FOR THE GARDEN

AT 41 NORTH QUEEN STREET, LANCASTER, PA.
BY THE NEW ERA PRINTING COMPANY.

PRESS OF
THE NEW ERA PRINTING COMPANY
LANCASTER, PA.

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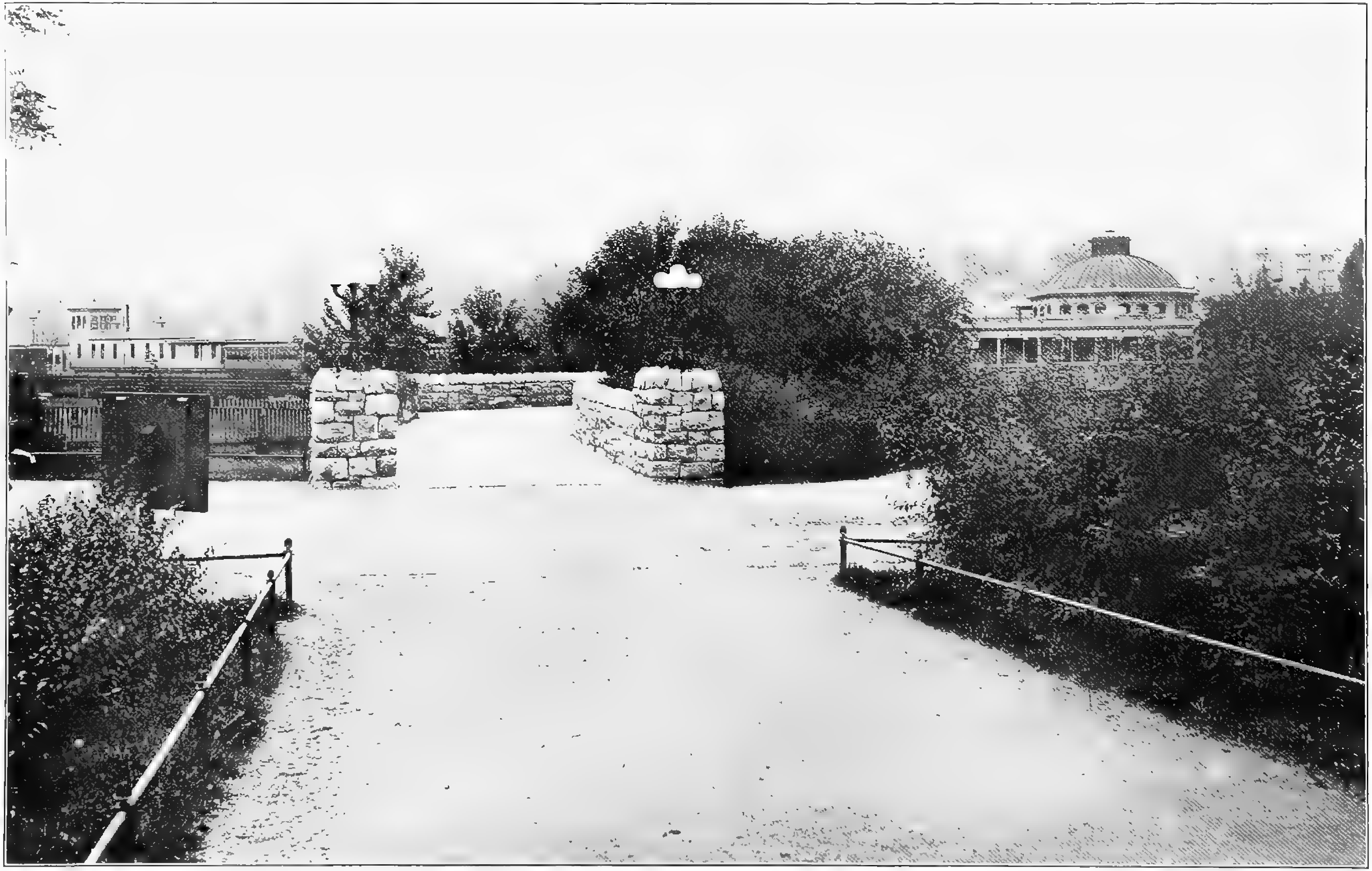


APPROACH TO ELEVATED RAILWAY STATION

BULLETIN
OF
The New York Botanical Garden
HUDSON-FULTON CELEBRATION NUMBER

Vol. 7. No. 23.

DESCRIPTIVE GUIDE TO THE GROUNDS, BUILDINGS AND COLLECTIONS

Location

The New York Botanical Garden is situated in the northern end of Bronx Park, the reservation including about 250 acres of land of a very diversified character, furnishing natural landscapes of great beauty and variety.

Means of Access

The Garden is conveniently reached in the following ways:

1. By the Harlem Division of the New York Central and Hudson River Railroad to Bronx Park Station.

2. By the Third Avenue Elevated Railway system to the terminal station of that road at Bronx Park.

3. By the Subway, Lenox Avenue and West Farms branch with transfer at 149th Street and Third Avenue to Elevated Railway, thence to Bronx Park Station.

4. By trolley car on Webster Avenue to 200th Street or the Woodlawn Road. This line connects with lines from the western part of the Bronx on Kingsbridge Road, and on Tremont Avenue, and also with the line to Yonkers.

5. By trolley line on the White Plains road east of Bronx Park from West Farms, Williamsbridge, and Mt. Vernon, connecting with lines from the eastern part of the Bronx at West Farms and at Mt. Vernon.

6. By driveways in Mosholu Parkway from Van Cort-

landt Park; from Pelham Bay Park through Pelham Parkway; through the Crotona Parkway and Southern Boulevard from Crotona Park; there are also driveway entrances at 200th Street, convenient for carriages coming from Jerome Avenue; at Newell Avenue, at the northern end of the Garden, for carriages coming from the north; at Bleecker Street on the eastern side of the Garden for carriages coming from the east; and at the Woodlawn Road, convenient for carriages coming from Yonkers, and from other points west and northwest of the Garden.

Purposes

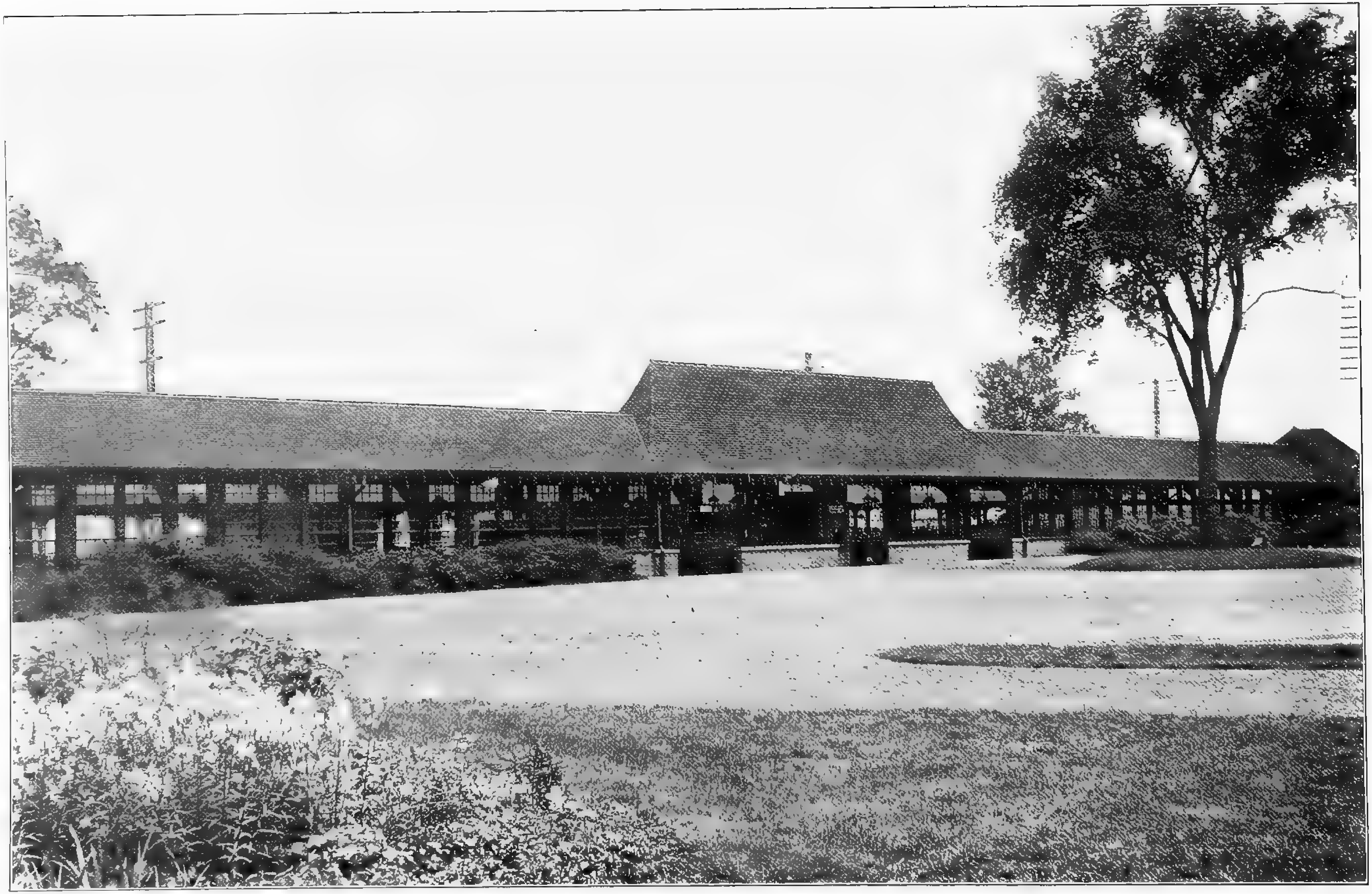
The New York Botanical Garden was established by an Act of the Legislature of the State of New York passed in 1891 and amended in 1894 "for the purpose of establishing and maintaining a Botanical Garden and Museum and Arboretum therein, for the collection and culture of plants, flowers, shrubs and trees, the advancement of botanical science and knowledge, and the prosecution of original researches therein and in kindred subjects, for affording instruction in the same, for the prosecution and exhibition of ornamental and decorative horticulture and gardening, and for the entertainment, recreation and instruction of the people."

General Plan

The general plan of development includes:

1. The largest conservatories in America, for the cultivation of plants of tropical regions, one located near the entrance at the elevated railway station, and a second very large range, partly constructed, near the Bleecker Street entrance on the eastern side of the Garden.

2. The largest botanical museum in the world, located near the Bronx Park station of the New York Central Railroad and the Mosholu Parkway entrance. This building includes a large lecture hall for public lectures in the basement; and the library, laboratories for instruction and research, and the herbarium, on the upper floor.



NEW YORK CENTRAL RAILROAD STATION

3. The pinetum, or collection of cone-bearing trees, mostly evergreens, which is being brought together on the hills and slopes on all sides of the conservatories, range 1, and in the space between that structure and the museum building.

4. The herbaceous grounds, situated in a valley east of the conservatories, range 1, near the Southern Boulevard entrance, containing collections of hardy herbaceous plants, arranged by botanical relationship, and also a collection of similar plants, arranged to demonstrate elementary botany; the economic garden, a plantation designed to illustrate hardy plants whose products are directly useful to man, is being installed in the northern part of the same valley.

5. The fruticetum, or collection of hardy shrubs, located on the plain northeast of the museum building at the Woodlawn Road entrance and extending northward into the north meadows; this collection is also arranged by botanical relationship.

6. The deciduous arboretum, or collection of trees which lose their leaves in the autumn, located along the entire eastern side of the grounds from south to north.

In addition to these artificial features, the following natural features are of special interest:

7. The hemlock grove, a forest of the Canadian hemlock spruce, clothing the hills between the museum building and the Bronx River and covering about forty acres, considerable portions of it being primeval.

8. The gorge of the Bronx River, extending south from the waterfall at the Lorillard Mansion, along the edge of the hemlock grove to the southern boundary of the Garden.

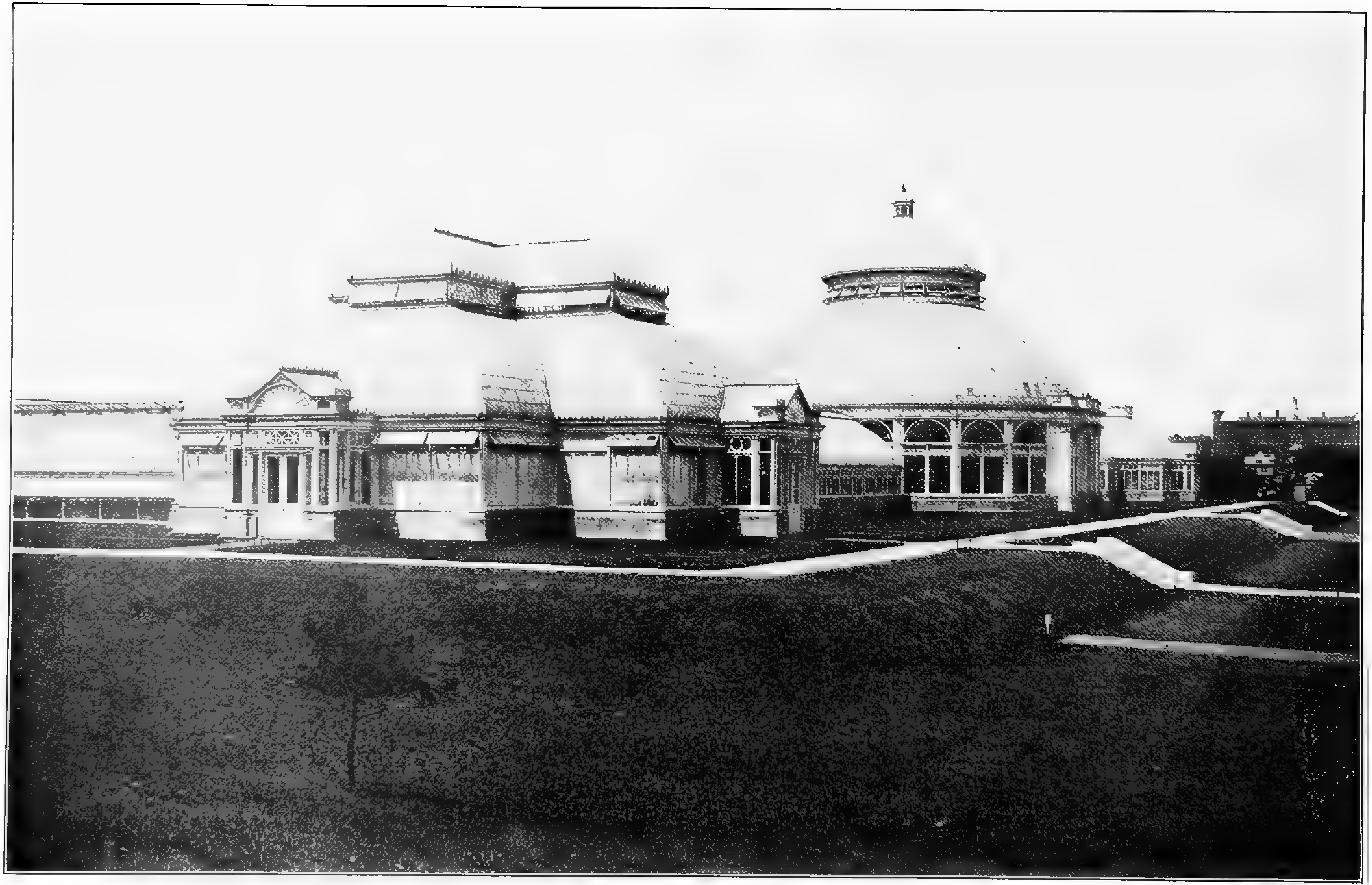
9. The north meadows and river woods along the Bronx River from the northern end of the hemlock grove to the northern end of the Garden.

1. The Conservatories

Range No. 1.

This great glass-house, located but a short distance from the terminus of the Third Avenue Elevated Railroad, is 512 feet in length, with a central dome about 90 feet in height, and wings extending from the main range in such a way as to form a court open to the southwest. The area under glass is about one acre. The building stands on a terrace 5 feet in height, approached by six flights of cut granite steps connecting with the path and driveway approaches. The house contains fifteen compartments, separated by glass partitions and doors.

House No. 1 contains palms of numerous species from all parts of tropical and warm regions, both of the Old World and the New. Of West Indian palms, the collection contains the royal palm of Cuba and Florida, an elegant plant of the corozo palm (*Acrocomia media*) of Porto Rico and the Windward Islands; the cocoanut palm, planted in all tropical countries for its fruit and for the numerous uses to which its fiber, wood and leaves are applied; it is not definitely known that the cocoanut palm is a native of the West Indies, and where in the tropical regions it actually originated is uncertain. Central and South American palms are illustrated by the delicate *Cocos Weddelliana* from Brazil, by the silvertop palm (*Coccothrinax argentea*), and by the curious Mexican *Acanthorhiza aculeata,* with spine-like roots on its trunk. Old World species are shown in a very large tree of the Chinese fan-palm, by the date palm (*Phoenix dactylifera*) of northern Africa, by the very broad-leaved *Phoenicophorium sechellarum,* native of the Seychelles Islands, and by numerous other large species from the Pacific islands. Related to the palms and shown by numerous specimens in this house, we find a number of species of the cyclanthus family, the most conspicuous being the Panama hat plant (*Carludovica palmata*), from the young leaves of which the costly Panama hats are made. Opposite the entrance to the court in this house, is a group of bamboos, which belong to the grass family, the most noteworthy of them being the Chinese bamboo (*Bambusa vulgaris*), whose stems reach into the upper part of the dome; this plant grows with great rapidity each year by new shoots which come up from under ground,



PUBLIC CONSERVATORIES, RANGE I.

our measurements showing that they reached 65 feet in height in 95 days, a rate of about 8 inches a day. The plant has been introduced into the West Indies, and in places where it grows its stems are put to a great variety of uses in construction, for water pipes and for various utensils.

House No. 2 also contains specimens of the palm family, the smaller specimens of tropical species being exhibited here.

House No. 3 contains specimens illustrating several families of monocotyledonous plants of tropical regions. The amaryllis family is represented by a number of species of the spider lily (*Hymenocallis*), bearing large white flowers, the commonest being *Hymenocallis caribaea* from the sandy coasts of southern Florida and the West Indies; large plants of the genus *Crinum,* some of which have white flowers and some red or purple, may be seen on the middle bench, and the maguey of the West Indies (a spiny-leaved relative of the century plant, native of the West Indies, and used there for hedges), on the northern bench; this name maguey is also applied in parts of the West Indies to species of *Agave,* which will be found in house No. 6.

Numerous representatives of the lily family, especially of the genus *Dracaena,* may be found on the south bench, and these are much used for ornamental planting in the tropics; here also are plants of the genus *Sansevieria,* the bow-string hemps of Africa; a valuable tough fiber is derived from their leaves; larger plants of the lily family may be found in the adjoining house No. 4, a portion of this house being given over to tall dracaenas and their relatives.

The arrow-root family is illustrated by the arrow-root (*Maranta arundinacea*), native of South America, but widely cultivated in the West Indies, its roots furnishing the commercial product; *Calathea* comprises a large number of tropical American plants noteworthy for their fine foliage, and there are other genera represented.

House No. 4. Here are brought together many kinds of large tropical plants belonging to families also represented in the smaller houses, but too tall to be grown on the benches.

The interesting screw-pines, natives of the Old World tropics, are illustrated by several species, the leaves of which are used in the manufacture of mats, hats and baskets. These plants are not at all related to pine trees, the latter part of the name referring to the slight resemblance the leaves bear to those of pineapple plants, which are commonly called *pines* in the tropics, while the remainder of the name was suggested by the spiral arrangement of the leaves.

In this house may be found large specimens of the aroid family, the most noteworthy one of these being a magnificent plant of Veitch's tail-flower (*Anthurium Veitchii*), from Colombia, which is believed to be the most elegant plant of its kind in cultivation; climbing on trunks of trees set as supports, will be found a number of vines of the genera *Philodendron* and *Monstera,* the latter a native of Mexico, producing an edible fruit with the odor of pineapple.

A large tree of the common rubber plant, much grown in parlors, may be found in the center of this house, reaching to the roof; this is a native of tropical Asia and yields some rubber, but not in as great quantity nor of as good quality as the other rubber trees of South and Central America; it is a species of fig (*Ficus elastica*) ; other species of *Ficus* are shown in this house, notably a fine tree of Roxburgh's fig, which bears its inedible fruit in bunches near the base of the tree, and a specimen of the Banyan tree (*Ficus benghalensis*). Chocolate trees (*Theobroma Cacao*), native of tropical America, may be found near the western door of this house; the small white flowers are produced on the trunk and on branches, and a few of them develop into the large woody pods containing the seeds or chocolate beans, which are dried and ground up into chocolate and cocoa; specimens illustrating the chocolate industry will be found in the economic museum. The papaya, or papaw, also of tropical America, is illustrated by a tall tree in the middle of this house; its fruit, esteemed as an aid to digestion, is borne just under the crown of leaves. A specimen of the bread-fruit tree (*Artocarpus incisa*) may also be seen here; originally from the islands of the Pacific, it was introduced into the West Indies in the latter part of the eighteenth century.

Several interesting tall vines climb on the pillars of this house, among them the night-blooming jessamine (*Cestrum Parqui*) of tropical America, which opens its flowers after dark and exhales a delicious perfume, the flowers remaining open during part of the morning; Henderson's *Allamanda*, of Brazil, with its showy large yellow flowers, climbs to the roof.

House No. 5. The plants in this house are from desert regions. Especial attention is called to their fleshy stems or leaves which serve as storage organs for a water supply to carry them over periods of drought. On the right hand bench, as one enters from No. 4, are mainly plants from southern Africa: the carrion flowers (*Stapelia*), relatives of our common milkweed of the roadsides; *Aloe, Gasteria, Haworthia,* and other South African representatives of the lily family.

The central bench is entirely devoted to the cactus family, which, with few exceptions, is American. Nearly all these plants are devoid of leaves, these organs, when present, being mostly small and inconspicuous; in the genus *Opuntia* they are usually present on the young growths as awl-shaped bodies, while in some few species they are much larger and remain for some time; in the genus *Pereskia,* specimens of which will be found in house No. 7, the leaves are large and well developed. The stems of the cacti are fleshy and assume a great number of forms; in *Opuntia* the stem is composed of joints, either cylindric or broad and flattened. In *Cereus* the stems are angled; in *Carnegiea* they are thick massive columns with many longitudinal ribs; in *Echinocactus* the plant-bodies are but little elongated, or almost globular, while in other genera the plant-body is covered with rows of spirally arranged projections. The flowers of many cacti are exquisite in form and color; they are borne on various parts of the plant-body, in the turk's-head cactus on a curiously modified portion of the top. A plant of economic interest here is

Nopalea coccinellifera upon which the cochineal insect breeds; it is from these insects that the dye cochineal is obtained.

On the remaining side bench is the stone-crop family, represented by many interesting and beautiful forms. The echeverias from Mexico and Central America, and the sempervivums, or house-leeks, from the Old World, are conspicuous among these. Many of the stone-crops are hardy plants and a collection of these may be found at the herbaceous grounds. Only a few cactuses are hardy. A large number of the specimens belonging in this house and the next may be found during the summer in beds in the conservatory court.

House No. 6. This is also a desert house. On the two corner benches to the right, as one enters from No. 5, is a collection of century plants (*Agave*), a large genus known only from the New World; other and larger plants of this same genus may be found in the central portion of the house. Conspicuous among these are: the thread-bearing agave, Queen Victoria's agave, the sisal plant (*Agave sisalana*) ; and the common century plant (*Agave americana*). The first two are decorative and curious; from *Agave sisalana* is manufactured the sisal hemp of commerce; the last, *Agave americana,* is well known, and it is from the sap of related species that the Mexican drink "pulque" is obtained by fermentation. It is popularly believed that the century plants flower but once in a hundred years, and then die; it is true that the plant dies when done blooming, but it blooms at a much earlier age than a century, sometimes when but eight or ten years old, it is said. A curious desert plant among the century plants on the side bench is called by the natives of Mexico, its native country, "huariqui" (*Ibervillea sonorae*) ; during the rainy season green stems arise from these large woody plant-bodies, which at other times remain in a resting condition.

A group of the lily family may be found in the central portion of this house. This comprises members of the genera *Aloe, Yucca* and *Dasylirion.* A group of cacti may also be seen here, the most imposing figure of which is the giant cereus, *Carnegiea gigantea,* known as "sahuaro" by the Mexicans and Indians of its native country, Arizona and Sonora. The plants here shown were obtained by an expedition sent to those regions by the Garden in 1902, and they represent perhaps the largest specimens in cultivation in the east. Several large specimens of the hedgehog cactus, secured at the same time, form part of this group. The Indians in the desert often secure a supply of drinking water from these plants by cutting off the top and macerating the interior substance. A number of other large and rare cacti secured by a Garden expedition of 1906 have recently been added to this collection. On the remaining corner benches may be found the fig marigolds, from southern Africa, desert members of the pineapple family, and representatives of the spurge family.

House No. 7. Many families are shown here, the representatives of which are tropical. The members of the mimosa and senna families, largely represented in this house, are curious in their sleep movements; as daylight wanes the leaves begin to droop and the leaflets to fold up. Belonging to the senna family may be mentioned: the logwood tree (*Haematoxylon campechianum*), widely distributed throughout tropical America; the copaiba tree (*Copaiva officinalis*), one of the trees from which copaiba is obtained; and the tamarind tree (*Tamarindus indica*), valuable for its fruit. In the mimosa family the humble or sensitive plant (*Mimosa pudica*), whose leaves fold at the least touch, is of peculiar interest. The mahogany tree (*Swietenia Mahagoni*), and the cocaine plant (*Erythroxylon Coca*), from South America, are important economic plants. In the custard-apple family are the cherimoyer (*Anona Cherimolia*), and the sour sop (*Anona muricata*). The mammee-apple is another tropical fruit, belonging to the gamboge family. The spurge family is represented in several curious forms, many of them much resembling members of the cactus family; while others bear large leaves, as is the case in the chenille plant, or Philippine medusa (*Acalypha hispida*) ; belonging to this family also is the plant bearing physic or Barbados nuts (*Jatropha Curcas*). The showy genus *Codiaeum*, commonly known as crotons, also belongs to the spurge family. Members of the cactus family, represented by several genera, especially of kinds growing naturally on trees in tropical forests, will be found near the spurge family. Decorative members of the ginseng family are also in this house.

House No. 8. As in house No. 7, the plants assembled here are of miscellaneous interest. The madder family is present in showy forms of ixoras, hoffmannias and rondeletias. There are striking forms of the potato family; also attractive representatives of the gesnerias, in the African or Usambara violet, and several forms of the genus *Trichosporum*, excellent basket plants. On the north side bench may be found a collection of begonias in many forms, ranging from the large-leaved *Begonia nelumbifolia*, of the West Indies, to the small-leaved *B. foliosa*, from Colombia, and the dainty little *B. rotundifolia*, known only from the island of Haiti, and for many years lost to science. The showy foliage forms of *Begonia Rex* are present in great variety. Among the more noteworthy economic plants are the ramie plant (*Boehmeria nivea*), a native of China, from the fiber of which the so-called grass-cloth is woven.

House No. 9. This is the aquatic house, and plants which find their homes in the water or require much moisture are brought together here. From the bridge spanning the pool the various features may be readily observed. Fringing the pool on the right, as one enters from house No. 10, are members of the sedge and grass families, while on the left hand side the fringe is made up entirely of grasses, largely of the graceful bamboos. Of special interest among the sedges is the Egyptian paper-plant (*Cyperus Papyrus*), from which many of the ancients obtained their writing paper. Among the grasses by far the most important is the sugar cane (*Saccharum officinarum*) ; from the lower portions of its stalks the juice is extracted by pressure, and from this juice sugar is manufactured. Among the plants in the pool are many with attractive flowers; conspicuous among these being water-lilies (*Castalia*), of which there are several different kinds; the water hyacinth; the parrot's-feather, with its delicate feathery masses of green; the water poppy; the water snowflake; the water lettuce, a member of the aroid family; the floating fern; and some odd little plants related to the ferns, members of the genus *Salvinia.*

House No. 10 contains specimens of the aroids, represented by a large number of different species. The plants of this family (*Araceae*) are mostly of tropical distribution, but they are represented in our northern flora by the skunk cabbage, the jack-in-the-pulpit, and the sweet flag; the most familiar one in cultivation is the calla lily (*Zantedeschia aethiopica*), not botanically a lily. The plants all have spikes of very small flowers closely massed together, and usually subtended by a broad leaf-like structure which is known as the spathe; this is usually highly colored, pure white, yellow, red or scarlet, and is commonly thought of as the flower, though not botanically so; species of *Anthurium,* known as tail-flowers, are abundant in the West Indies and tropical America, as is the genus *Philodendron,* signifying tree-loving, on account of many species being vines climbing high on the trees in tropical forests; numerous species have underground stems and branches which contain much starch and are cultivated in the tropics for food, under the name of yautias and taras. Plants of the same family, too large for exhibition in this house, may be found in house No. 4. This house is occupied also by plants of the pineapple family. These are mostly plants which live on the trunks and branches of trees in tropical forests, and are therefore called epiphytes, signifying plants growing upon other plants; many of them are exceedingly beautiful in foliage and in flower; the so-called Florida moss, or Spanish moss, clothes the trees of the live-oaks in the southern Atlantic States, and is not a moss at all, but a plant bearing small flowers which show its relationship to others of this family. The pineapple itself, doubtless the most familiar member of this group, has been cultivated in tropical regions for an indefinite period for fruit, and is not certainly known in the wild state; the pineapple fruit is the ripened bunch of flowers which forms at the top of the stem; the plant is propagated by cutting off the tuft of leaves, which is found on the top of the fruit, and by suckers which sprout from the side of the plant near the ground; it is an exception to the tree-loving habit of most of the family, in growing on the ground, and is cultivated in the Bahamas and on the Florida Keys, often in very rocky soil. One of the very spiny-leaved species, *Bromelia Pinguin,* is widely utilized as a hedge plant in the West Indies. Hanging from the rafters on both sides of this house may be found baskets containing the East Indian pitcher-plants, *Nepenthes;* these are mostly vines, growing naturally on trees, their leaves curiously modified at the ends into hollow structures provided with lids and technically known as pitchers, which are often wrongly regarded as the flowers; these pitchers contain water and secrete from their sides a glutinous liquid which digests insects that fall or crawl into the pitchers; this form of nutriment is apparently not necessary at all, however, to the growth of the plants; the flowers are small but borne in large clusters arising from the stems and may often be seen in this collection.

House No. 11. Here are brought together many kinds of tropical plants belonging to the banana, ginger and canna families. There are also here a few plants of the pineapple family too tall to be shown on the benches in house No. 10. The collection of bananas and their relatives occupies the greater part of the space and one or more of the specimens is usually in fruit; the collection contains both the edible, commercial bananas and the plantains, and also several species whose fruit is not edible, but whose interest lies in their decorative leaves and flowers. The stems and leaves of all these plants contain some fiber, which is produced in enormous quantities in the Philippine Islands from *Musa textilis,* and is the well-known Manila hemp. The supply of fruit for the United States comes mostly from Central America and the West Indies, and some from northern South America. Bananas will grow in southern Florida, but the rocky soil of that region is not well adapted to their cultivation. The traveler's tree, from Madagascar, is shown in several fine specimens, and gets its English name from the fact that the axis of each long leaf-stalk contains a grat deal of water which can be tapped and drunk. The bird-of-paradise plants, which take their name from their gaudy flowers, will be found in this group; they are natives of southern Africa and belong to the genus *Strelitzia.* Another genus of the banana family, *Heliconia,* is also represented by several species, called wild plantains, natives of tropical America.

Here also may be found several species of the genus *Costus* and of other genera of the ginger family, including the ginger plant (*Zingiber Zingiber*).

House No. 12. The plants in this house, as well as those in house No. 14, are mostly natives of warm-temperate regions, and are arranged in botanical sequence, with a view to furnishing a collection for the comparative study of plant families and genera; to make this as complete as possible, as many representatives of families and genera are brought together as space and cultural conditions permit. Cultural requirements necessitate placing the ferns and their allies somewhat out of their sequence position, at the south end of the west side bench. The east side bench is devoted to the pine family, the yew family, and to the endogenous plants, the last named terminating with the orchids, next the banana house. The sequence of exogenous plants begins on the west side bench, as one enters from house No. 13, crosses to the central bench at the ferns, and continues around that, ending in this house with the loasa family, near the fern house. The sequence is then continued in house No. 14, beginning with the mezereon family on the north side bench, at the entrance from house No. 13, continuing around the central bench and ending with the thistle family on the end of the south side bench near the entrance to house No. 13.

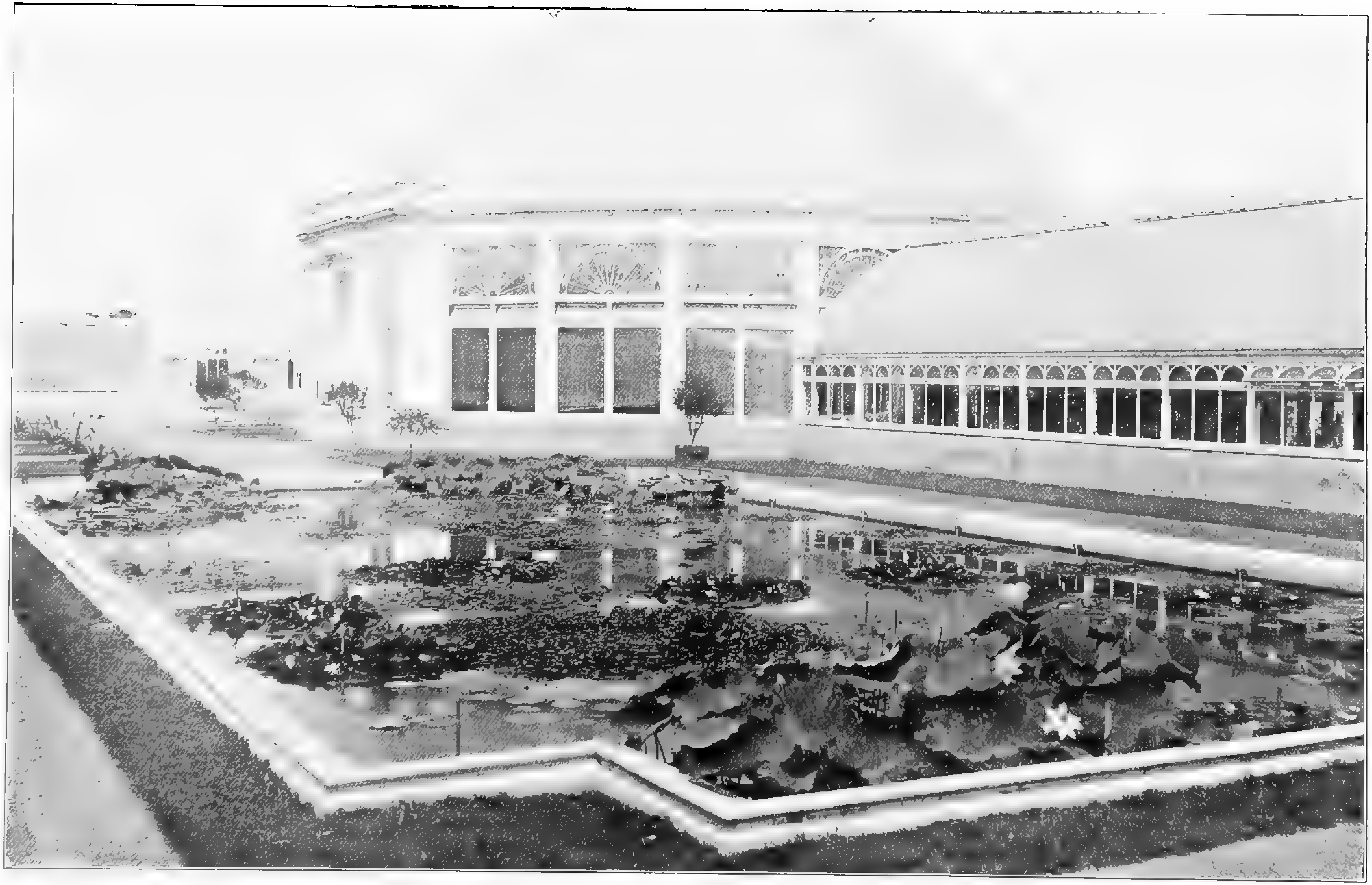
Among the more interesting species on the west side bench are many Australian plants, represented by grevilleas, hakeas, and others; a group of insectivorous plants may also be found here; among these are the pitcher plants (*Sarracenia*) in several species; the pitchers contain a liquid in which the insects are drowned, the fluid resulting from their decay being absorbed by the pitchers; these structures form a part of the leaves and are a modification of the petiole. The sundews (*Drosera*) secrete a sticky substance from the gland-hairs on their leaves, which can digest insects and other animal matter. On the central bench may be found a group of the rue family; to this belong, among others, the oranges and lemons, of which a number of small specimens are here, others being placed in house No. 13. A peculiar plant of this family is *Agathosma apiculata,* of southern Africa; its leaves are full of glands which secrete an oil exhaling a disagreeable odor quite apparent at times. On the east side bench are members of the lily family and the amaryllis family, with many other endogenous plants, including a collection of orchids which grow in warm temperate regions or in the mountainous sections of the tropics. In the yew family, perhaps the most interesting are two small plants of the "stinking cedar" (*Tumion taxifolium*) so-called by the natives where it grows; it is known to occur in a wild state in a small area along the Apalachicola River in Florida.

House No. 13. This house contains such plants of warm-temperate regions as are too large for proper exhibition in houses 12 and 14. The endogenous plants may be found on the side next house No. 14; the remainder of the house is occupied by exogenous plants. Opposite the entrance from house No. 14 is a group illustrating the pine family and the yew family. The most conspicuous objects among the former are the araucarias, which take the place in the southern hemisphere of the pines in the north; *Araucaria brasiliana* and *A. Bidwillii* are prominent among these; the common Norfolk Island pine (*Araucaria excelsa*) is shown in several large specimens. To the right of this, across the path, will be found specimens of the New Zealand flax (*Phormium tenax*), and on one of the trellises in the rear is a vigorous plant of the Cherokee rose. To the left, a little beyond the pine family, is the myrtle family; prominent in this is a group of the gum-trees of Australia and Tasmania (*Eucalyptus*); these trees occur in large forests, and sometimes attain a height of 200 to 400 feet. A large specimen, some ten or twelve feet tall, of the bottle-brush tree (*Callistemon citrinus*) will be found here; the red flowers are borne in long cylindric clusters, much resembling a common bottle-brush, whence the popular name. Farther to the left is a large plant of *Hydrangea hortensis;* this presents a gorgeous show of blue flowers early in the summer. In the corner to the right is a specimen of the camphor tree (*Cinnamomum Camphora*), from which the camphor of commerce is derived. Opposite the camphor tree is a group containing the common garden camelia, and the important commercial plant, *Thea sinensis,* from which is obtained our beverage tea; black and green teas are obtained from the same plant, the difference in color being due to the method of preparation; the tea plant is extensively cultivated in many warm and tropical countries, tea as a beverage having been used by the Chinese from time immemorial; its first introduction into Europe is said to have been by the Dutch in 1610. Further along to the left, beyond the group of Australian acacias, of which there are many specimens, are several plants of the fig tree (*Ficus Carica*), from which the edible figs are secured; the leaves drop off in winter, and so for a short time the plants are placed elsewhere. A little beyond these to the left may be found a group of oleanders; a poisonous principle occurs in the flowers and leaves of these plants, and especially in the bark. A plant of great economic importance in the olive family is the olive tree (*Olea europaea*), of which a small specimen may be found near the oleanders; this plant was originally from the Mediterranean region and the Orient, but has now been largely introduced into cultivation in other warm countries; in the middle of the eighteenth century it was first introduced into

California, at San Diego, it is said, and is now largely cultivated in southern California. On one of the columns near the olive is a fine plant of *Bougainvillaea,* a native of Brazil; the bracts which surround the small flowers are bright magenta colored; when in full bloom the plant makes a gorgeous show. On one of the trellises back of the group of the amaryllis family is a plant of the yellow jessamine (*Gelsemium sempervirens*) of the south; it sends out its pretty flowers usually in February, and they persist for several weeks. In this house may also be found a number of palms. Among these may be mentioned the characteristic fan-palm of the California desert (*Neowashingtonia robusta*), and the palmetto (*Sabal Palmetto*), of our southern States. A few temperate tree-ferns are also placed here.

House No. 14. The general arrangement of this house was mentioned when describing house No. 12. Entering from house No. 15, to the left may be found plants of the rosemary; this enjoys a reputation of long standing, for it was held in high esteem by the ancient Greeks and Romans, being regarded by them as the emblem of fidelity. A little further to the left is the parachute flower (*Ceropegia Sandersoni*), from Natal. On the right are many interesting members of the thistle family. On the other side of the house may be found *Aucuba japonica,* from Japan, and *Corokia Cotoneaster,* from New Zealand, both members of the dogwood family, but not much resembling our common flowering dogwood. Other plants of interest may also be found here.

House No. 15. The orchid family, to which this house is devoted, is a widely distributed one, occurring in all tropical regions, but finding its greatest development in the Old World in India and the Malayan region, while in the New World its greatest numbers occur in Brazil and other parts of northern South America. In temperate regions relatively few species are found, while in very cold countries they are entirely absent. Most of the tropical forms are epiphytes, that is, they grow upon trees and usually have bulb-like or thickened stems and fleshy leaves for the conservation of



COURT OF PUBLIC CONSERVATORIES, RANGE I.

their water supply, as, from their habitat, this supply must be precarious. In temperate regions nearly all of the species are terrestrial, and have thin leaves, the soil about their roots serving to protect them from the cold and also giving them a more constant water supply: they do not, therefore, need pseudobulbs or thickened stems. Coming from all parts of the world as they do, their blooming time varies greatly, so that at almost any time of the year, be it winter or summer, some of these interesting plants may be found in bloom.

On the central bench is an interesting palm, the double cocoanut (*Lodoicea maldivica*), a native of the Seychelles Islands, also known as the coco de mer, and coco des Maldives, and one of the rarest palms in cultivation; in the specimen here shown the upper portion of the seed may be seen projecting above the soil. The tree in its native wilds attains a height of ninety feet, bearing aloft a magnificent crown of green leaves which make it an important feature of the landscape. This is the only plant in this house not a member of the orchid family; it is kept here for cultural reasons.

Conservatory Court. There are two attractive features here during the open season, viz., the water lily collection and the collection of desert plants. The water lilies may be found in two tanks, one in each end of the court. In the easterly tank are placed the hardy sorts, such as are able to withstand the severe cold of our winters, which remain permanently where they are, winter and summer. In the westerly pool are the tender kinds, or such as require protection during the winter, and many of these are stored in a warm cellar during winter and placed on view again in the spring. The most conspicuous of the tender sorts are the royal water-lilies from South America; these are not hardy in this climate, and, as they are too large to protect from the cold, they are grown anew from seed each year; the seeds are sown in the propagating houses late in winter, and the young plants placed on view late in the spring or in early summer.

In summer the collection of desert plants is in three beds in front of the entrance to house No. 1. The central bed contains American desert plants only, made up largely of members of the cactus, amaryllis and lily families; in the easterly beds will be found desert plants from southern Africa. In the western bed are representatives of the orpine family.

Conservatory Flower Beds. To the north of the conservatories, occupying a portion of the area below the terrace, are several large plots devoted to a miscellaneous display of shrubs, evergreens and herbaceous plants. Attractive flowers may be seen here from the earliest spring until late autumn, while the evergreens make a pleasing effect during the winter. The herbaceous plants are plainly labeled, thus adding much to their interest for the visiting public.

Range No. 2

This range, four houses of which have been constructed, is located on the easterly side of the grounds, in the midst of the deciduous arboretum. The completed portion consists of a transverse range, running east and west, divided into three compartments, and a smaller house at right angles to this range. The tropical ferns and their allies and the cycads are exhibited here.

In the easterly compartment of this transverse range the collection of sago palms or cycads has been installed. This family of plants is represented by large specimens of *Cycas revoluta,* from Japan; by *Cycas circinalis,* from the Molucca Islands; by a single plant of the rare *Stangeria eriopus,* from southern Africa, where it is known as the kaffir's-head; by a number of specimens of the genus *Zamia,* including the small Florida coonties; and by the Kaffir-bread (*Encephalartos*), two species, from Africa; the stems and trunks of plants of this family contain much starch, which is extracted, in the countries in which they grow, by crushing and washing, and pass into commerce under the name of sago starch.

In the middle and westerly houses of the transverse range may be found the tropical tree-ferns and the larger specimens of the low ferns and fern-allies.

The graceful tree-ferns usually inhabit the mountains of the tropics, commonly at an elevation of 1500 feet or more. Many of the plants here have been secured by Garden expeditions to different parts of the American tropics. Another feature of interest is the collection of staghorn-ferns, hanging over the walk in the center house; the application of the common name staghorn is quite evident in several of the species. Suspended from the roof in baskets are many desirable ferns. A fern from China and Tartary, known as the Scythian Lamb (*Cibotium Barometz*), may be found here; it is of interest as forming the basis of a marvellous tale, current in early times, to the effect that on a vast plain to the eastward of the Volga occurred a wonderful plant, looking like a lamb; this animal, so the story ran, was supported upon a stalk and as soon as it had exhausted the vegetation at hand died from starvation.

In the small house may be found a collection of tropical ferns arranged in botanical sequence, thus bringing closely related families and genera into juxtaposition and enabling a comparative study of these plants to be made. It is only possible to represent in this sequence the position of the tree-ferns by very small specimens. These may be studied to better advantage in the larger houses.

Power Houses. Steam for heating the conservatories, range 1, is supplied from the power house, located near the New York Central Railroad just south of the 200th Street entrance and connected with the conservatories by a subway about six hundred feet long containing the steam mains; five boilers are installed and supply steam not only to the conservatories, but also to the museum building through another subway about twelve hundred feet in length.

Steam for heating the conservatories, range 2, is supplied from a boiler house near this structure, a little to the north.

2. The Botanical Museum

The Museum Building has a frontage of 312 feet, and in so far as now constructed, a depth of about 90 feet; the plan of this building contemplates its future extension toward the rear, so as to form a quadrangle enclosing a court. The architectural style of the building is Italian Renaissance. The walls are of light-colored brick and the trimmings of terra-cotta. It has a steel frame and concrete floors. Three floors are devoted to public exhibits, while the upper floor contains study rooms, the library, laboratories and herbarium, which may be used and consulted by permission.

The building is approached by two straight driveways and accompanying sidewalks leading from the main park driveway near the New York Central Railroad station; this front approach to the building is ornamented by a bronze fountain executed by the sculptor Carl E. Tefft, and by terra-cotta fountains and marble seats designed by R. W. Gibson, the architect of the building. The vista lines are formed by four parallel rows of trees.

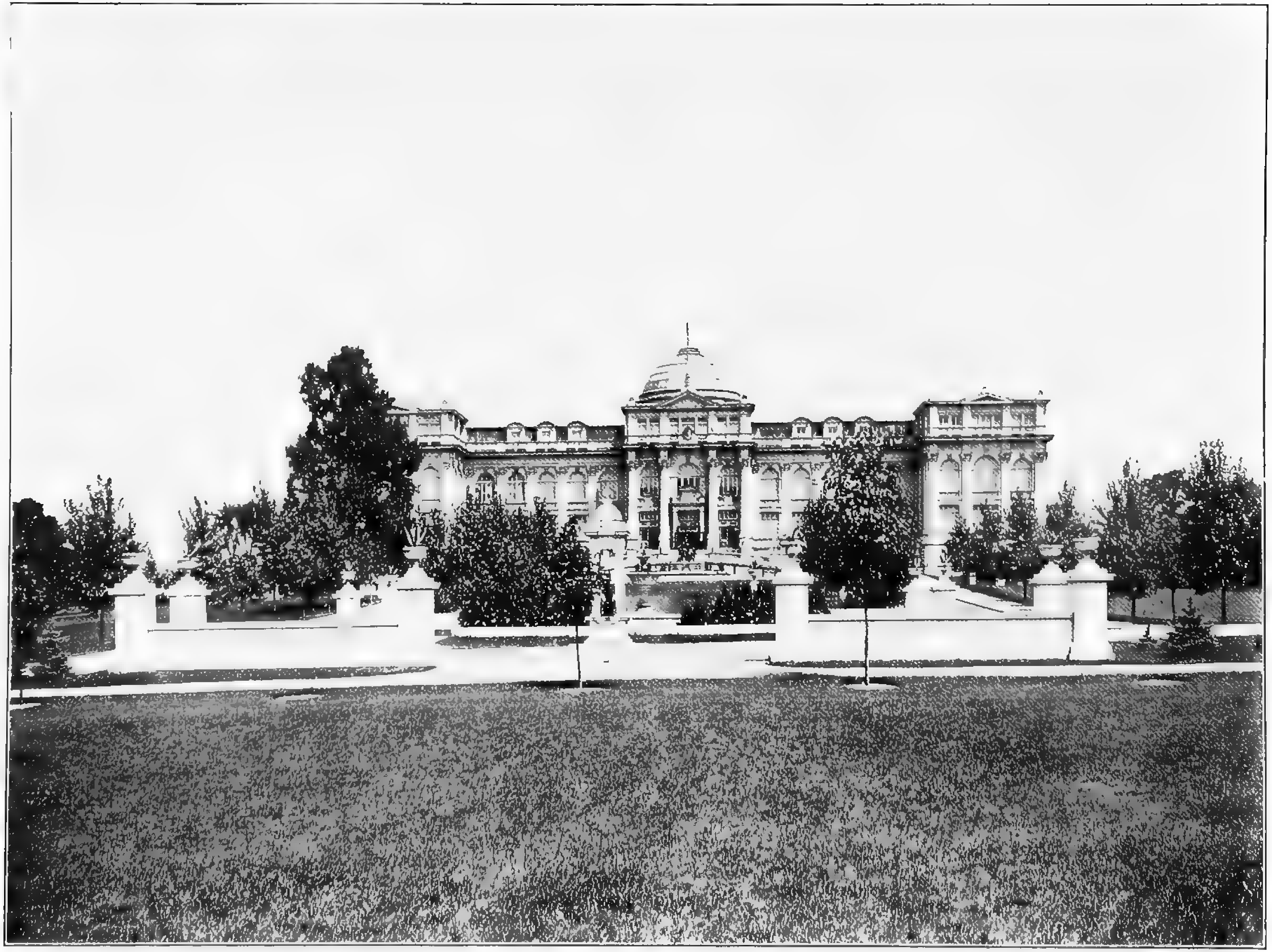
The public collections in this buildings are:

1. THE MUSEUM OF ECONOMIC BOTANY

This occupies the entire main floor, and here are brought together both crude and refined products of plants used in the arts, sciences and industries, illustrated also by photographs and drawings. The specimens are arranged as products, including food, drugs, fibers, gums, resins, sugars and others as indicated by the accompanying floor plan.

The arrangement of the larger groups is as follows: Foods and fibers occupy the west hall, the former in cases on the north side, the latter on the south. The west wing is mainly given over to exhibits other than foods, fibers, drugs and woods. The east hall contains the drugs, while the east wing is set aside for the woods and wood products, and for a collection illustrating North American dendrology.

Fibers. Cases 1 to 18.—In the first case of the series



THE MUSEUM BUILDING

devoted to fibers may be found cotton, the most important of the vegetable fibers. It is derived from the fruit of the cotton plant (*Gossypium*), being the hairs that cover the surface of the seeds. The fruits of several different kinds of cotton may be seen with the cotton bursting from the capsule, while some of the many different products are also shown.

The fiber of many other plants, derived from the leaves, stem, bark, roots and other organs, is of great economic importance and is used, either in practically its natural condition, as may be seen by the specimens of fans, hats, boxes, bags, baskets, mats, matting, crude ropes, brooms, ornaments and toys, or it is manufactured into articles of commerce after processes which remove it considerably from its natural aspect or condition; for example, linen, which is made from the flax, plant; cloth, twine and rope, from jute, hemp and abutilon fiber; and paper made from wood and other fibers.

India Rubber and Allied Products. Cases 19 and 20.—The first case in the west wing contains india rubber and allied products. Here are the implements and utensils used in collecting the rubber "milk" from the trees which grow in the tropical forests. Rubber is derived mostly from trees belonging to the mulberry family, spurge family and dogbane family.

Several varieties of rubber may be seen in the different stages of refinement, together with some articles as manufactured for the market. Here, too, is an allied product, gutta percha, which is derived from the trunks and foliage of certain trees belonging to the sapodilla family. These trees grow in many portions of the tropics.

Resins. Cases 21 and 22.—The cases devoted to resins contain on the one hand a large trunk of the long-leaf pine, with a turpentine box, together with a series of specimens of turpentine and resin, illustrative of the trade-classification of these products, and, on the other hand, a series of resins derived from other species of pine and related trees, and also those from trees representing the mulberry family, the mimosa family, the sumac family and the myrrh family.

Spices and Flavoring Agents. Cases 23 to 26.—These substances form quite a large series in which is shown the parts of the plant that yield spices and flavoring extracts; for example, licorice is extracted from the roots of the licorice plant. Ginger is a rootstock, the underground stem of the ginger plant; cinnamon is a bark; bay, sage, mint, thyme are leaves; cloves are flowers; coriander, allspice, black pepper, celery seed, caraway seed, vanilla bean and tonka bean are fruits; mustard and nutmeg are seeds, and mace is the outer coat of the nutmeg.

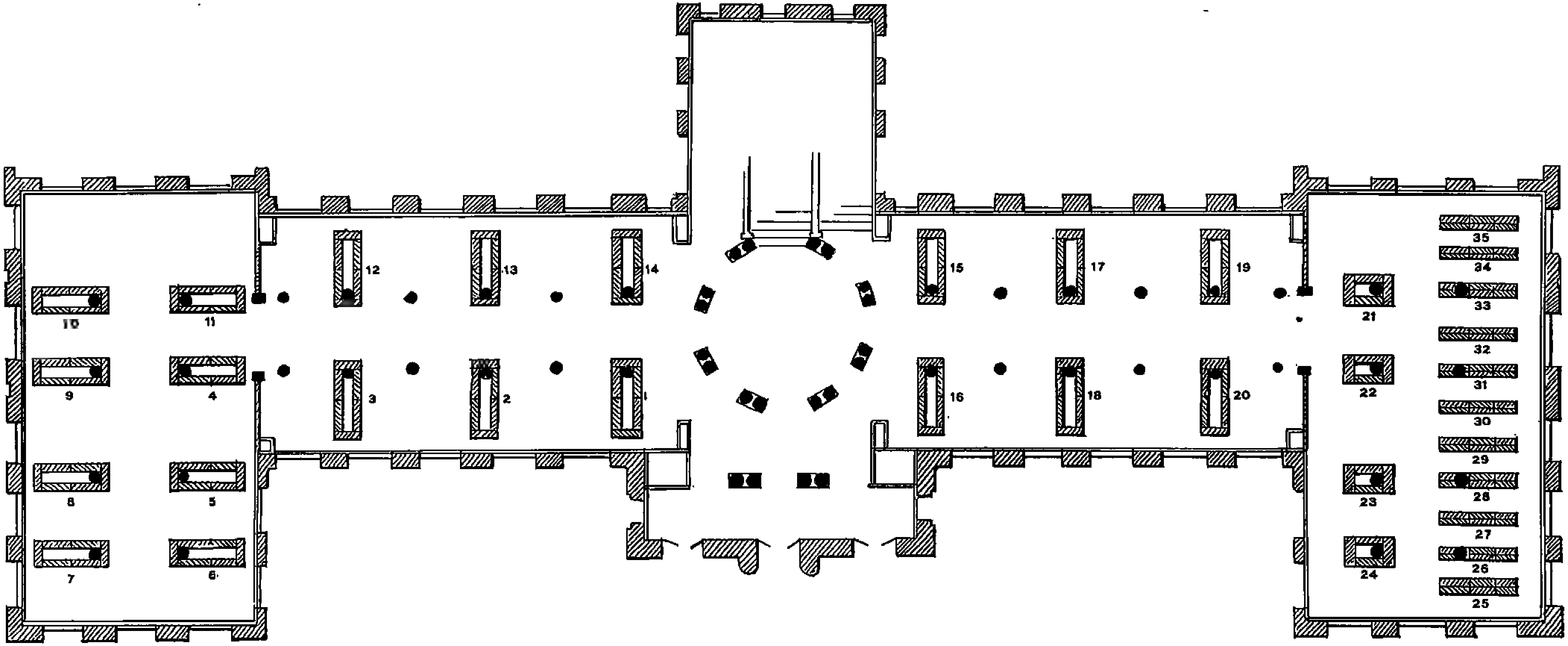
Dye Stuffs. Case 27.—The dye stuffs are represented by logwood, madder, alkanet root, indigo and oak galls.

Tanning Materials. Cases 28 to 30.—The tanning materials are also very important from an economic standpoint; they are represented by saw-palmetto, mangrove, pine, hemlock and sumac. The crude materials of the mangrove and the saw-palmetto are accompanied by the fluid extract which contains the tannic acid and also by the spent material or refuse which remains after the extract has been made.

Fodder Plants. Cases 31 and 32.—Following the spices are fodder plants, which are shown as sheaves, and consist of grasses, sedges, bush-clovers and related plants.

Tobaccos and Masticatories. Cases 33 to 36.—Tobaccos are shown by a series of bundles of the cured leaves of the tobacco plant (*Nicotiana*) from different parts of America, and a series of articles as prepared for the market. Closely associated with tobacco are the masticatories or substances used for chewing. One of the most widely known forms is chewing gum, which is made by refining the crude chicle-gum, which is the hardened milky juice of the sapodilla and related plants. In rural districts the exudation of resin found on the bark of conifers is used for chewing while still in the crude condition, but this substance is now refined and sold in our larger cities just as is the now more commonly used chicle-gum. An adjacent case is given over to:

Beverages, including Chocolate. Cases 37 to 41.—Beverages are represented by both the non-alcoholic, as coffee,



FLOOR-PLAN, MUSEUM OF ECONOMIC BOTANY

1–3. Cases 1–18. Fibers.
4. Cases 19 and 20. India Rubber and Allied Products.
Cases 21 and 22. Resins.
5. Cases 23–26. Spices and Flavoring Agents.
6. Case 27. Dye Stuffs.
Cases 28–30. Tanning Materials.
Cases 31 and 32. Fodder Plants.
7. Cases 33–36. Tobaccos and Masticatories.
Case 37. Chocolate.
Cases 38 and 39. Coffee.
7. Cases 40 and 41. Beverages.
Case 42. Miscellaneous Specimens.
8. Cases 43–48. Fixed and Volatile Oils.
9 and 10. Cases 49-60. Plant Constituents.
11. Case 16. Starches.
Cases 62–64. Cork and Paper.
Cases 65 and 66. Sugars.
12-14. Cases 67-84. Foods.
15–20. Cases 85–102 and 185-202. Drugs.
21–35. Cases 103–184. Woods and North American Dendrology.

tea, maté or Paraguay tea, Jersey tea and fruit juices, and the alcoholic and malt beverages, as wine, beer, ale and porter. In the block of cases devoted to beverages may be found chocolate, which is derived from the seed of the chocolate tree (*Theobroma*). The collection shows the chocolate fruits, the principal commercial varieties of the seeds, unroasted and roasted, nibs of different degrees of fineness, germs, cocoa-liquor, cocoa-butter, cocoa-cake, and the same ground into "breakfast"-cocoa, with several varieties of confectioners' chocolate, as put up for the market.

Miscellaneous Specimens. Case 42.—In this case may be seen the substances used in the manufacture of soap, insect powders and related substances.

Fixed and Volatile Oils. Cases 43 to 48.—The volatile oils form a large series, and in their manufacture various parts of the plants are used; for example, roots are used to make the oils of lovage-root, elecampane and muskroot; rootstocks furnish the oils of calamus, ginger, orris root and wild ginger; herbage is the source of the oils of pennyroyal, tansy, spearmint and peppermint; wood furnishes the material to make the oils of red cedar wood and sandalwood; bark is the source of the oils of birch, cinnamon and sassafras; leaves yield the oils of hemlock, spruce, pine, cedar, eucalyptus and wintergreen; flowers yield the oils of cloves, lilac flower and orange flowers; fruits yield the oils of pepper, lemon, caraway and fennel; seeds furnish the oils of mustard, wormseed, nutmeg and almonds; while resins give us the oils of elemi, mastic, myrrh and frankincense.

The fixed oils, at least from a commercial standpoint, are less numerous than the volatile oils, and those in common use are mostly derived from the fruits and seeds of plants; for example, olive oil is contained in the fruit of the olive, linseed oil is contained in the seed of the flax plant, castor oil is stored up in the seed of the castor oil plant and cotton oil abounds in the cotton seed. Fixed oils differ from volatile oils in not completely evaporating when exposed to the air. In many cases the by-products resulting during the manufacture of the various oils are of considerable commercial importance. Some of these by-products are shown in the cases with the oils.

Plant Constituents. Cases 49 to 60.—This exhibit consists of a series af alkaloids, acids, glucosides and amaroids, albuminoids, resinoids and enzymes. These substances plants store up in their tissues, or in the tissues of one or more organs, and from them they are extracted for use in all branches of the arts, sciences and industries.

Starches. Case 61.—Starch, as in the case of many other substances, exists in and is consequently derived from the several organs of various plants, for example, the roots of the cassava plant furnish the cassava flour and tapioca, while those of coontie yield coontie flour which is quite similar to sago, and those of the sweet potato plant furnish sweet potato flour. The rootstocks of the common potato plant abound in potato flour, while those of the arrow-root plant yield arrw-root flour. The stems of some of the sago palms and those of some of the true palms are the sources of sago flour. The fruits, both dry and fleshy, of a great variety of plants, contain starch; for example, those of the several grains, wheat, rye and corn; while those of the banana yield the less common banana flour. The seeds of some plants are used as a source of starch, as for instance, those of the chocolate plant.

Cork and Paper. Cases 62 to 64.—Cork is the light outer bark of the cork oak tree, a tree indigenous to southern Europe. The substance, as we are accustomed to see it, is prepared by means of boiling the cork bark and scraping off the rough outer portion. The crude cork and many manufactured articles are shown in case number 49, and a large jacket of crude cork is exhibited near by, just as it was stripped from the tree.

Wood fiber, especially that obtained from the trunks of the spruce and poplar, enters largely into the manufacture of paper. In cases 48 and 50, the fiber is shown in its crude condition and in the various stages of refinement, as well as the various qualities of paper into the structure of which it enters. Here also are the several stages and substances connected with the production of straw paper.

Sugars. Cases 65 and 66.—Sugar is a very important plant-product and it is of vast economic value. Sugar cane (*Saccharum*) is the basis of the world's sugar supply. The juice from the stems of the plant is boiled down and by other processes is made into the principal crude products shown in the cases and later into the commercial grades of sugar.

The juices of other plants are also used in making sugar, for example, in temperate regions, the sugar beet yields an enormous amount, the sap of the maple tree is made into maple sugar, while in tropical regions the sap of various palms, such as the cocoanut palm and the sugar palm, is made into palm sugar.

Foods. Cases 67 to 84.—The very important section of vegetable foods occupies the cases on the north side of the west hall, opposite those containing the fibers. Here may be seen the various plants and parts of plants commonly used for food. In a few instances nearly the whole plant is available, as in the mushroom, the morel and the truffle. Usually, however, certain parts only are nutritious or desirable; a few examples of these are as follows: sweet potatoes, horseradish, carrots and beets are roots; onions, potatoes and Jerusalem artichokes are rootstocks; asparagus and poke shoots are young stems; lettuce, beet-tops, spinach and parsley are leaves; cauliflower and calamus-buds are inflorescences; corn, rice, bananas, mulberries, gooseberries, apples, tomatoes and oranges are fruits; while peanuts, walnuts, hickorynuts, beans, almonds and chestnuts are seeds.

Drugs. Cases 85 to 102 and 185 to 202.—The east hall is given over to drugs. This, like the department of foods, is large and important. The active principles or medicinal agents are stored up in the tissues of the plant or in special organs. The great majority of refined drugs are derived from one or more of the parts of the plant, but in the case of the white agaric, ergot, Irish moss, Iceland moss, wintergreen, sundew, bitter-sweet, pennyroyal, boneset and tansy the whole plant is used.

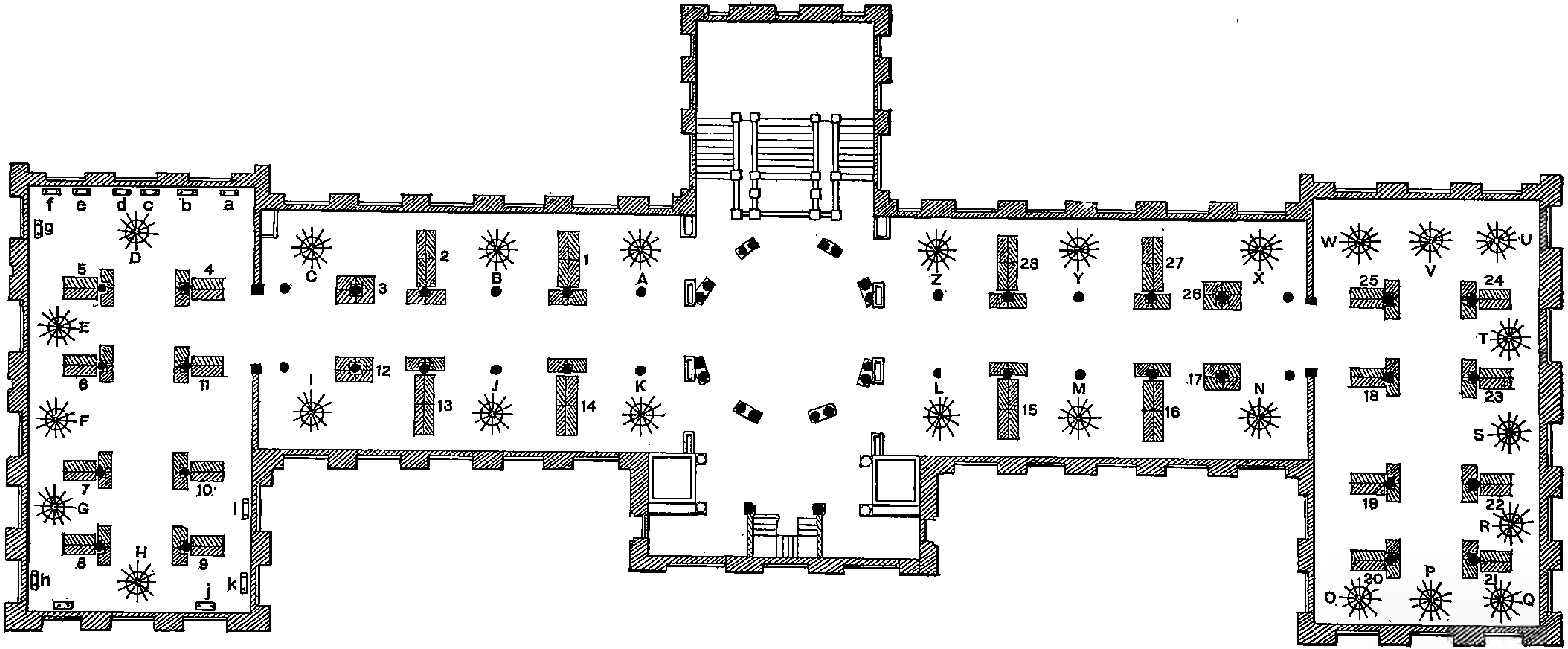
A few of the crude drugs arranged under the several plant-organs they represent are as follows: sarsaparilla, poke-root, rhubarb, aconite, queen's root, senega root, marshmallow, man-in-the-ground and ipecac are roots; calamus, ginger, colic-root, Canadian snake-root, soapwort, mandrake, American ipecac, buckbean and stonewort are rootstocks; sandalwood and quassia chips are woods; sassafras medulla is pith; birch, slippery elm, sassafras, cinnamon, wild cherry, horsechestnut, cascara, linden and cinchona are barks; laurel, hardhack, cherry laurel, peach, senna, coca and eucalyptus are leaves; red-clover flowers, orange flowers, linden flowers, heart's-ease, borage flowers, safflower, marigold flowers, Roman chamomile, German chamomile and milfoil flower are flowers and flower-heads; saw-palmetto, cardamon, cubebs, hops, star anise, poppy, rose hips, tamarind, Tonka bean and colocynth are fruits; colchicum seed, grain of paradise, betel nut, mustard, delphinium seed, almonds, calabar bean, Barbadoes nut, castor oil seed and henbane seed are seeds.

Woods. Cases 103 to 184.—The east wing is occupied by woods. The exhibits fall under two main divisions, the one consisting of a series of wood-specimens from all parts of the world, and crude wood-products such as pipes, canes, shoes, sandals, utensils and carbons or charcoals; the other being a synoptic collection illustrating North American dendrology.

2. THE MUSEUM OF SYSTEMATIC BOTANY

This occupies the entire second floor of the building and is designed to illustrate by specimens, drawings and photographs, types of all the natural families of plants, beginning with those of the simplest structure and ending with the most complex. It consists of three series of objects:

(*a*) The general synoptic collection.
(*b*) A series of microscopes showing selected specimens.
(*c*) Illustrations of the local flora.



FLOOR-PLAN, MUSEUM OF SYSTEMATIC BOTANY

1–28. Synoptic Collection.
1– 8. Cases 1. Slime-moulds.
Cases 2–16. Sea-weeds.
Cases 17–36. Fungi.
9–11. Cases 37–40. Hepatics.
Cases 41–48. Mosses.
12 and 13. Cases 49–55. Ferns and Fern-allies.
12–28. Cases 56–58. Cone-bearing Plants.
Cases 59–128. Fruit-bearing Plants.
A–Z. Local Flora.
a–k. Microscope Exhibit.

a. Synoptic Collection. This is designed to illustrate the plant world. A series of characteristic objects is installed as a basis for illustrating each plant-family. These specimens are accompanied as far as possible by plates, drawings or photographs, while on the shelves are arranged additional objects, such as flowers, fruits, woods, specimens of fossil plants and models of various organs of plants, all intended further to illustrate the structural characteristics of the different groups. This collection is arranged according to the most natural and thus far most generally satisfactory interpretation of the interrelation of the plant-families; it may be considered as falling into two main series, namely, the flowerless or spore-bearing plants and the flowering or seed-bearing plants.

The flowerless plants fall into three subkingdoms: (1) the Thallophyta, in which the plant-body is not differentiated into stems and leaves, represented by the slime-moulds, the bacteria and other micro-organisms, the seaweeds, the fungi and the lichens; (2) the Bryophyta, represented by the mosses and their immediate relatives; and (3) the Pteridophyta, including the ferns and the fern-allies.

The Thallophyta (cases 1 to 36), may be defined as plants without true roots, stems or leaves, but notwithstanding their simple structure they exhibit an infinite variety of form and color.

The Myxomycetes or slime-moulds (case 1), standing at the bottom of the plant scale, occupy the first exhibition case placed at the right hand side of the stairway from the main floor. They are thallophytes, having neither chlorophyl nor (in their vegetative condition) a cell-wall. These very simply constituted plants usually grow upon and derive their nourishment from decaying organic substances. They vary greatly in size, some being exceedingly minute, others assuming the form of relatively large irregularly shaped masses spreading in all directions as they grow. Most of the plants are small, and the structure is very delicate, in fact some are so fragile that a mere breath of air will ruin them.

Following the slime-moulds stand the cases devoted to the algae or seaweeds (cases 2 to 16), which may be briefly defined as thallophytes with chlorophyl, the green coloring matter of plants. The plants of this series are much more variable in form than those of the preceding, and are also much more numerous. Some forms are microscopic, others attain considerable size. The first case of the series is occupied by representatives of the blue-green algae (case 2) and the diatoms. The plants of these two groups are minute, so much so that in most cases the individuals can be well seen only with the aid of a microscope. As one finds them in nature they commonly form slimy or oozy masses which are not particularly attractive to the naked eye, but under a compound microscope they are of very great interest. Following the series just mentioned are the green seaweeds (case 3), the group which includes the plants that are sometimes called the pond-scums, green slimes, green felts and stoneworts. Some of these are microscopic; however, some of the green seaweeds attain a considerable size and begin to look a little more like what are popularly termed "plants." After the green seaweeds come the brown ones (cases 4 to 8), and here the largest kinds are included. In their tissues is found a brownish pigment which obscures their green coloring matter. To this group belong the widely distributed "gulf-weed" or "sargasso-weed" (*Sargassum*) and the gigantic "great kelp" of the Pacific Ocean, which is said to attain seven hundred feet in length. The seaweeds culminate in the red algae, a group in which the plants show some shade of red, pink or purple; these (cases 9 to 16) exhibit a marvelous range of form and color. The last group of cases containing this series is given to the group of red algae which are known as the corallines, on account of their outward resemblance to the corals. These plants are thoroughly permeated with lime and are often as hard and stone-like as any coral, and build up reefs in the tropical oceans much as the corals do.

The next great type of plant life is the fungi (cases 17 to 36). These, like the plants of the preceding group, vary greatly in size and complexity of structure; but, unlike them, they are devoid of chlorophyl, the characteristic green matter which enables other plants to build up complex food for their nourishment, and consequently they are wholly different in their mode of life. Some are parasitic, deriving their nourishment from living plants and causing enormous damage to crops; others are saprophytic, deriving it from the remains of dead organisms; while others are symbiotic, living in such relationship with chlorophyl-bearing (green) plants that they mutually nourish one another, as in the case of lichens and mycorhizas. There are five generally recognized series here: First we have the stalked-spored fungi (cases 17 to 28). This series falls into two groups, the one typified by the "rusts" and "smuts" which are commonly parasitic on the leaves and fruits of other plants; the other the great saprophytic group, well known through the mushrooms, bracket-fungi, stink-horns and puff-balls. Second in the series is the group known as the imperfect fungi (case 29). In this group the spores are borne directly on the threads or "hyphae" which constitute the vegetative portion of the organism. They are often parasitic on the leaves and on the bark of both wild and cultivated plants. Third in this series are the spore-sac fungi (cases 30 and 31). In these plants the spore are borne in delicate membranous sacs, called asci, which in the more complex forms are collected into bodies of various shapes. The plants vary greatly in size and structure and are both parasitic and saprophytic. To this group belong the yeasts and mildews. Some plants grow above the surface of the ground, as in the case of the morel; while others are subterranean, as in the case of truffles. Next in order are the alga-like fungi (case 32); these vary in form from simple masses of protoplasm to simple or branching threads. Here belong many of the moulds and similar forms which grow both on other plants and on animals. The fifth and in many respects the most interesting of all the groups is that consisting of the lichens (cases 33 to 36). The fungi thus far considered are either parasitic or saprophytic in their mode of life; the lichens form an independent symbiotic group, each lichen consisting of a fungus and an alga living together, the one nourishing the other. The lichens are quite familiar to most people as plants of more or less leathery texture growing on rocks, on poor soil or on the trunks of trees.

A step forward brings up to the Bryophyta, or seedless plants with roots, stems and leaves, but without vascular tissue (cases 37 to 48). This group is best known through the mosses, which form its largest division; but of simpler structure are the hepatics or scale-mosses (cases 37 to 40); although they were formerly associated with the true mosses, their tissues are much less differentiated than those of the mosses and the structure of their various organs much less complicated. The stems and leaves of the hepatic plant are sometimes combined into a flat thallus-like body which creeps closely on the ground or other objects and resembles in aspect some of the more simply organized plants. The leaves, too, are more like scales than in the true mosses and they do not have a midvein. These differences alone enable one to distinguish a hepatic from its relatives by the unaided eye or at most by the use of a lens. In addition to these characters, the capsule or the receptacle which bears the spores, or reproductive bodies, usually splits into four valves when full-grown and the spores themselves are accompanied by spiral threads called *elaters*. The favorite habitat of hepatics is wet places, and mountains continually steeped in clouds yield a surprising variety of forms. Closely related to the hepatics is the group Anthocerotes; these plants may, however, be distinguished by the presence of a central axis or column (columella) in the capsule, and there are several other important structural differences in their tissues.

The mosses (cases 41 to 48) follow the hepatics in order of development and complexity; they differ from them, however, in many respects. The stem and leaves have more differentiated tissues, and the leaves usually have a midvein. The moss capsule generally opens by a lid under which there are commonly appendages to aid in scattering the spores, which in this case are not accompanied by spiral threads as they are in the hepatics. The mosses fall into three primary groups: First the "peat-mosses" (*Sphagnum*) which differ from the rest of the mosses in the development of the tissue-structure of the capsule and the spores; they grow in swamps and other wet places, and their accumulation forms peat. The "black mosses" (*Andreaea*) differ from both of the other groups in the valvular capsule; they grow on dry rocks. The true mosses vary exceedingly in size and aspect. An examination of the specimens in the exhibition cases will convey to the mind a better idea of this group than a description. They grow under all kinds of conditions from dry rocks to deep water. Many of the kinds grow on almost any kind of rock, earth or bark of trees, while certain ones are more particular as to their habitat. Some will thrive only on limestone, which they often gradually disintegrate and partially preserve in the masses of closely set plants as a calcareous tufa; other species prefer ground that has recently been burnt over, as species of *Funaria* and *Leptobryum,* while others grow only on the bones of dead animals or in places where animal refuse has accumulated.

Next higher in the plant kingdom is the subkingdom Pteridophyta, or ferns and fern-allies, the seedless plants with roots, stems, leaves and woody tissue (cases 49 to 55). The ferns as a group perhaps attract the attention of a greater number of people than any other group of plants. However, associated with what are usually known as ferns are the fern-allies, for example the "horse-tails" (*Equisetum*), "lycopods" (*Lycopodium*) and "quillworts" (*Isoetes*), but these are usually less conspicuous than the "ferns." Fern-plants differ from all the plants of simpler organization in having vascular (woody) tissue, that is, a system of vessels for conducting sap through the different parts of the plant-body. They exhibit an almost infinite variety of form; their stems may be underground, horizontal on the ground, or erect; the leaves are either simple or compound, and sometimes perform both the work of foliage leaves and that of bearing the spore-cases (ferns), while in other cases some of the leaves have become changed into mere spore-bearing organs (horse-tails).

The flowering plants (cases 56 to 128) comprise a single subkingdom, the Spermatophyta, or seed-bearing plants. This extensive group seems to have followed two independent lines of development and consequently the plants fall into two well marked groups, the first being the gymnosperms, cone-bearing plants, or plants in which the seeds are borne exposed in variously shaped cones (cases 56 to 58). This is a comparatively small group, but exhibits great diversity, including plants ranging from straggling shrubs or vines to the largest trees. The leaves, too, vary from structures resembling needles or scales to expanded fern-like structures of considerable variety. In a former geological age these plants were the dominant seed-bearing plants, but now the second group of the spermatophytes largely predominates; namely, the angiosperms, fruit-bearing plants, or plants in which the seed is borne in a seed-case. These plants also existed in the later geological ages, and now form the most important and conspicuous part of the vegetation of the earth. The fruit-bearing plants (cases 59 to 128) fall into two divisions, the one in which the seed contains a single leaf, the monocotyledons (cases 59 to 71); the other in which the seed contains two leaves, the dicotyledons (cases 72 to 128).

b. Microscope Exhibit. The exhibition microscopes occupy small stands in the west wing of the second floor. In front of the windows on the right as one enters the wing are shown a few of the simplest and smallest forms of plant life. Under the first microscope is a preparation showing the vegetative condition of one of the slime-moulds, organisms in which the characteristics of plant and animal are so little differentiated that it is nearly impossible to affirm with confidence that they belong either to the one kingdom or to the other. In the vegetative stage — the stage here exhibited — the organism is strikingly similar in its essential attributes to some of the lower animals. Later, in the reproductive stage, there is at least a superficial resemblance to the fungi, which are undoubted plants. By means of the second microscope the spore-bearing stage of a slime-mould may be seen. The stalks and the netted framework of the spore-case walls remain, but the spores have mostly fallen. A few of the spores, however, appearing like minute dark dots, can be detected, adhering to the network. Under the lenses of the third microscope are representatives of the diatoms—one-celled organisms, some of which have the power of animal-like locomotion. The living substance of each cell is enclosed and protected by a hard transparent glassy wall consisting of two halves, one of which fits into the other like a band-box into its cover. Following this are shown "sea mosses," or "seaweeds," as they are commonly known, and closely related minute plants which inhabit fresh water and belong to groups often referred to in popular speech as "pond-scums" or "ooze." In the natural unmagnified condition, many plants of this sort seem quite the reverse of attractive, but when placed under a sufficiently powerful microscope many of them reveal a rare beauty. The "sea mosses," or "seaweeds," gradually lose much of their natural beauty of coloration on prolonged exposure to the light, but the pervailing elegance and symmetry of form and structure persist.

Following the plants of the seaweed type are several representatives of the smaller fungi. The specimens exhibited are chiefly from among those which grow upon decaying organic refuse. One interesting parasite exhibited is a fungus parasitic upon another fungus, which, in turn, is a parasite on the leaves of the common lilac. Another fungus shown lives chiefly within the cells of the underground parts of one of the orchids, yet it can scarcely be called a parasite, inasmuch as its presence in the tissues of the orchid is beneficial to the orchid as well as to itself. Of the fungi which live upon deceaying refuse matter, *Ascobolus* is one of the more interesting among those selected for exhibition. In this, the spores, or propagating cells, are borne in groups of eight within transparent ellipsoidal sacs, and at maturity these sacs, each enclosing eight spores, are ejected with considerable force. Under two microscopes are shown sections of lichens, illustrating their mode of reproduction and the fact that a lichen consists essentially of two organisms, a fungus and an alga, intimately associated and constituting what for many purposes may be looked upon as a single organism.

Then follow specimens of the liverworts or scale-mosses, plants in which the differentiation of the vegetative body into stem and leaves becomes first clearly evident. One of these, a *Frullania,* has a part of each leaf peculiarly modified so as to form a reservoir for water. By aid of this device, the frullanias and their allies are able to thrive in drier situations than are in favor with most of the order to which they belong. Preparations are exhibited showing also the vegetative structure and methods of reproduction of the true mosses. Especially interesting is the "peristome" of one of the mosses, which is a fringe of peculiar appendages surrounding the mouth of the little urn in which the minute dust-like spores are borne. These appendages move about as a result of changing conditions of moisture and these mechanical movements assist in scattering the spores. A somewhat analogous device is found in connection with the spores of the equisetums or horse-tails, though the appendages in this case are attached to the spores. Following the slide illustrating this feature of the horse-tails is one showing the spores and spore-cases of the common polypody. The spore-case here is provided with a sort of spring, by the action of which the spores are violently ejected, catapult-fashion. The remaining preparations show the structure of the leaf-stalk and root of common types of ferns.

c. Local Flora. In this collection it is designed to illustrate every plant-species growing naturally or without cultivation within one hundred miles of New York City. For the most part specimens of the plants themselves are used, but in cases where the structure of the plants renders this method undesirable, or impossible, a photograph or a drawing is substituted for the plant-specimen. This collection

FLOOR PLAN, MUSEUM OF FOSSIL BOTANY

Floor and wall cases 1. Plants of Eozoic Time, Laurentian Period, and Paleozoic Time, Cambrian, Silurian, Devonian and Carboniferous Periods.
Floor and wall cases 2–4. Plants of Paleozoic Time, Carboniferous Period.
Floor case 5. Plants of Mesozoic Time, Triassic and Jurassic Periods.
Wall case 5. Specimens showing methods of fossilization.
Floor case 6. Plants of Mesozoic Time, Cretaceous Period (Raritan).
Floor case 7. Plants of Mesozoic Time, Cretaceous Period (Raritan and Cliffwood).
Floor case 8. Plants of Mesozoic Time, Cretaceous Period (Dakota).
Floor case 9. Plants of Mesozoic Time, Cretaceous Period (Laramie).
Floor case 10. Plants of Neozoic Time, Tertiary Period (Eocene).
Floor case 11. Plants of Neozoic Time, Tertiary Period (Miocene).
Floor case 12. Plants of Neozoic Time, Tertiary (Miocene and Pliocene) and Quaternary Periods.

is displayed in swinging frames which are placed so as to correspond in a general way to the sequence of the cases of the synoptic collection already described; thus, the first stand is near the first museum case as one enters the west hall from the top of the staircase. All of the plant groups are here represented by those members that occur locally, and the characteristics of the several groups as mentioned under the Synoptic Collection also apply here.

3. THE MUSEUM OF FOSSIL BOTANY

This collection, installed in the basement, is designed to show the successive stages of evolution through which the ancestors of our living flora have passed since the time of the first appearance of plant life on the earth, as far as the remains of extinct plants have been preserved. The general arrangement adopted is therefore based upon the sequence of the geological time divisions: Eozoic, Paleozoic, Mesozoic and Neozoic, and their subdivisions into periods; Laurentian, Cambrian, Lower Silurian, Upper Silurian, Devonian, Carboniferous, Triassic, Jurassic, Cretaceous, Tertiary, Quaternary and Modern. This arrangement is therefore geological, but incidentally it is also biological, and follows the same system as that on which the synoptic collection of the museum of systematic botany is arranged, inasmuch as the plants of the earlier periods are low in the scale of life, consisting of thallophytes and pteridophytes and plants of uncertain botanical determination, while those which appear in the successively later periods are of successively higher and more complex types, represented by cycads, conifers and both monocotyledonous and dicotyledonous plants closely related to our living flora.

The series of exhibits begins in the first cases to the left as one enters the east hall of the basement. The sequence of the specimens in the wall cases corresponds to that of the floor cases.

In floor- and wall-cases Nos. 1 to 4 may be seen representatives of Eozoic and Paleozoic Time: Laurentian, Cambrian, Lower Silurian, Upper Silurian, Devonian and Carboniferous Periods. In floor- and wall-case No. 1 are specimens of graphite of eozoic age and of anthracite and bituminous coal of carboniferous age, showing the transformation of vegetable matter into the ultimate condition of pure carbon in the form of graphite or "black lead" in the oldest rocks. Other specimens in this case, classed as algae, are of uncertain botanical relationship, as the structure of the primitive plants was not well adapted for preservation as fossils. For example, some organisms appear as mere filamentous strips of graphite in white limestone, without any trace of the original structure remaining, while others may be seen as casts and impressions which closely simulate in general appearance different parts of the seaweeds now existing. In this series of problematic fossils are also included a number of forms at one time definitely classed as plants but now by some assumed to be of animal or inorganic origin; namely, *Scolithus,* which may be caused by worm burrows; *Phytopsis,* which may be a coral; *Plumalina,* which may be a hydroid; *Dendrophycus,* which may be current-markings; and *Dictyolites,* which are most likely sun-cracks. All of these, however, have at one time or another been definitely regarded as the remains of marine plants and were originally so described and classified.

In these cases and in wall-case No. 2 are also the remains of the earliest fern-plants and their allies (Pteridophyta) of Devonian and Carboniferous age, represented by *Lepidodendron, Sigillaria* and *Calamites,* and the early seed-bearing plants, the cone-bearers (Gymnosperms), represented by *Cordaites,* with the fossils under *Trigonocarpon, Rhabdocarpon* and other genera.

Floor-cases Nos. 2 and 3 and wall-case No. 3 contain specimens of Carboniferous age, for the most part ferns or fern-like plants, which were originally described as ferns, but which are now placed in a different group, the Cycadofilicales, that is, plants that had characteristics of both the ferns and the sago-palms, but more closely related to the latter than to the ferns.

Floor- and wall-cases No. 4 are devoted to specimens of Carboniferous plants in the genera *Lepidodendron, Sigillaria* and *Stigmaria,* in order to show the variation in the arrangement and shape of the leaf scars and the difference between specimens with the bark preserved and those which have been decorticated.

Floor-case No. 5 contains types of early Mesozoic time: Triassic and Jurassic Periods.—The plant remains in this case are mostly sago-palms or cycads, with a few cone-bearers and fern-plants, besides specimens of the so-called "*Glossopteris* flora," a flora of uncertain botanical relationship, which flourished in the transition period between Paleozoic and Mesozoic time, particularly in the southern hemisphere, and may yet be represented by the living South African genus *Stangeria,* a cycad having leaves with pinnately arranged forking veins, similar to ferns.

Floor-case No. 6 embraces plant remains from the rocks of later Mesozoic time: Lower and Middle Cretaceous Period.—These specimens represent the first appearance of the higher seed-bearing plants (Angiosperms), the type which is dominant in the existing flora. The genera are in most instances apparently identical with those now in existence, but the species are extinct. The plants of the Lower Cretaceous consist largely of ferns and cone-bearers, while those of the Middle Cretaceous show a preponderance of angiosperms.

Floor-case No. 7 is arranged to show specimens of the Middle Cretaceous flora found within the limits of the City of New York, on Staten Island, or in the immediate vicinity, in New Jersey and on Long Island.

Floor-case No. 8 contains specimens from the Middle Cretaceous of the western States. Those from the Dakota Group are exceptionally fine, many of them being perfectly preserved and showing both cast and impression of the same leaf as counterparts.

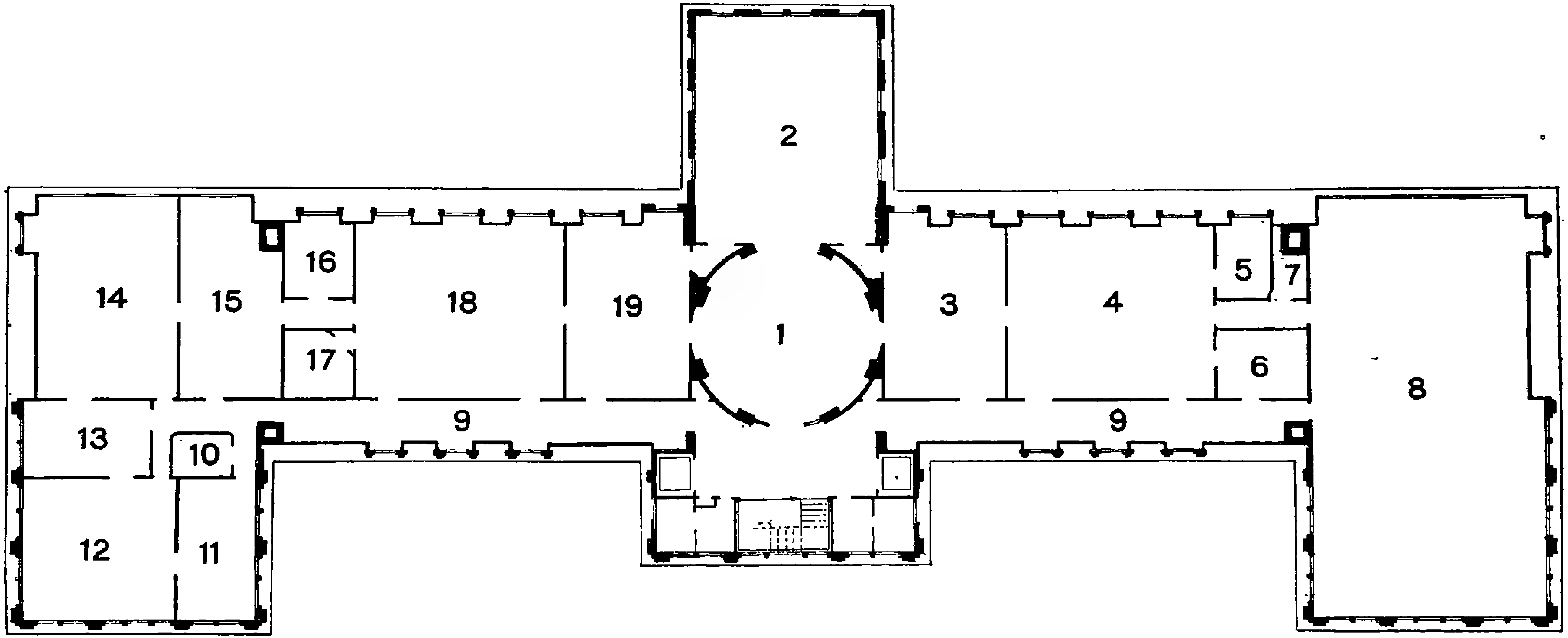
Floor-case No. 9 is devoted to plants of the Upper Cretaceous (Laramie Group), and completes the vegetation of Mesozoic time.

Floor-cases Nos. 10 to 12 and wall-case No. 5 contain plant remains of Neozoic time. Those of the early Tertiary Period (Eocene) are displayed in floor-case No. 10. Those of the later Tertiary (Miocene) and Quaternary Periods in floor-cases Nos. 11 and 12. The specimens in the latter case complete the sequence of plant life on the earth and bring it up to modern times. A number of specimens at one end of the case show the methods of preservation by petrification, incrustation and carbonization, and on the upper shelf is a series of specimens from Quaternary and more recent swamp deposits which show how the conversion of living plants into fossils, a process now going on, has its beginning.

The specimens in wall-case No. 5 further illustrate the characteristics of the plants of the late geological periods and the methods by which the various plant structures have been preserved. A number of specimens of silicified woods show the method of preservation by what is known as petrifaction, or conversion into stone, in which the woody structure is replaced by mineral matter. Other specimens show preservation by incrustation, in which mosses and the stems of reeds are coated or incrusted by mineral matter deposited from springs; while on the upper shelf and on the top of the case are logs and stumps from old swamps and interglacial deposits, in which the wood has been partially carbonized, or converted into lignite, by the slow process of natural distillation. This process represents the beginning of the conversion of vegetable tissue into coal.

LECTURES

Other features of the museum building include the large public lecture hall, with a seating capacity of over seven hundred, which occupies the western end of the basement. It is equipped with an electric projection-lantern, and public popular lectures covering a wide field of botanical and horticultural subjects are delivered here on Saturady afternoons in autumn and spring; these are fully illustrated by means



PLAN OF UPPER FLOOR OF MUSEUM BUILDING

1. Library Reading Room.
2. Library Stack Room.
3. Director's Laboratory.
4. Herbarium of Fungi.
5. Curator's Room.
6. Moss Herbarium.
7. Storeroom.
8. Main Herbarium.
9. Hall.
10. Photographic Dark Room.
11. Balance Room.
12. Chemical Laboratory.
13. Study.
14. Physiological Laboratory.
15. Study.
16. Study.
17. Physiological Dark Room.
18. Morphological Laboratory.
19. Herbarium of Algae.

of a very extensive collection of lantern slides owned by the Garden which is constantly being increased; a noteworthy part of this collection is the series of delicately and accurately colored slides of flowers, fruits, trees and shrubs, by Mrs. Adelaide S. Van Brunt, from photographs made during many years by her late husband, Cornelius Van Brunt.

A series of lectures to the pupils and teachers of public schools, designed to illustrate and supplement their work in nature study, is given in the large lecture hall on afternoons in autumn and spring, and these lectures are attended by many thousand children.

The Horticultural Society of New York holds several of its monthly meetings at the Garden, using the large lecture hall, and also uses the basement museum hall adjacent for the purpose of exhibitions.

The Torrey Botanical Club holds monthly meetings from October to May, on the afternoon of the last Wednesday of each month, in the museum building, and many of its field meetings on Saturday afternoons throughout the season are held at the Garden.

THE LIBRARY

The library of the Garden is located in the center of the upper floor of the museum building, and is available for consultation, by permission. It has been formed by the Board of Managers in order to provide for the use of students, all the literature of botany, horticulture and related sciences, and is rapidly becoming one of the most complete collections in the world of books and pamphlets dealing with these subjects.

THE HERBARIUM

The herbarium consists of dried specimens of plants systematically arranged in cases; it occupies the greater portion of several rooms on the upper floor of the museum building, and is available for consultation by permission. It contains prepared specimens of all kinds of plants from all quarters of the globe, and is the most extensive and complete collection of its kind in America.

THE LABORATORIES

Laboratories and working rooms for research are provided on the upper floor of the museum building, and properly qualified students of botany are permitted to make use of this equipment, under the direction of some member of the staff of the Garden. The equipment is designed to meet the needs of a very broad field of investigation including plant chemistry, pathology, physiology and morphology. A valuable series of old microscopes, illustrating the history and development of that instrument, has been presented by Mr. Charles F. Cox.

3. The Pinetum

[COLLECTION OF CONE-BEARING TREES]

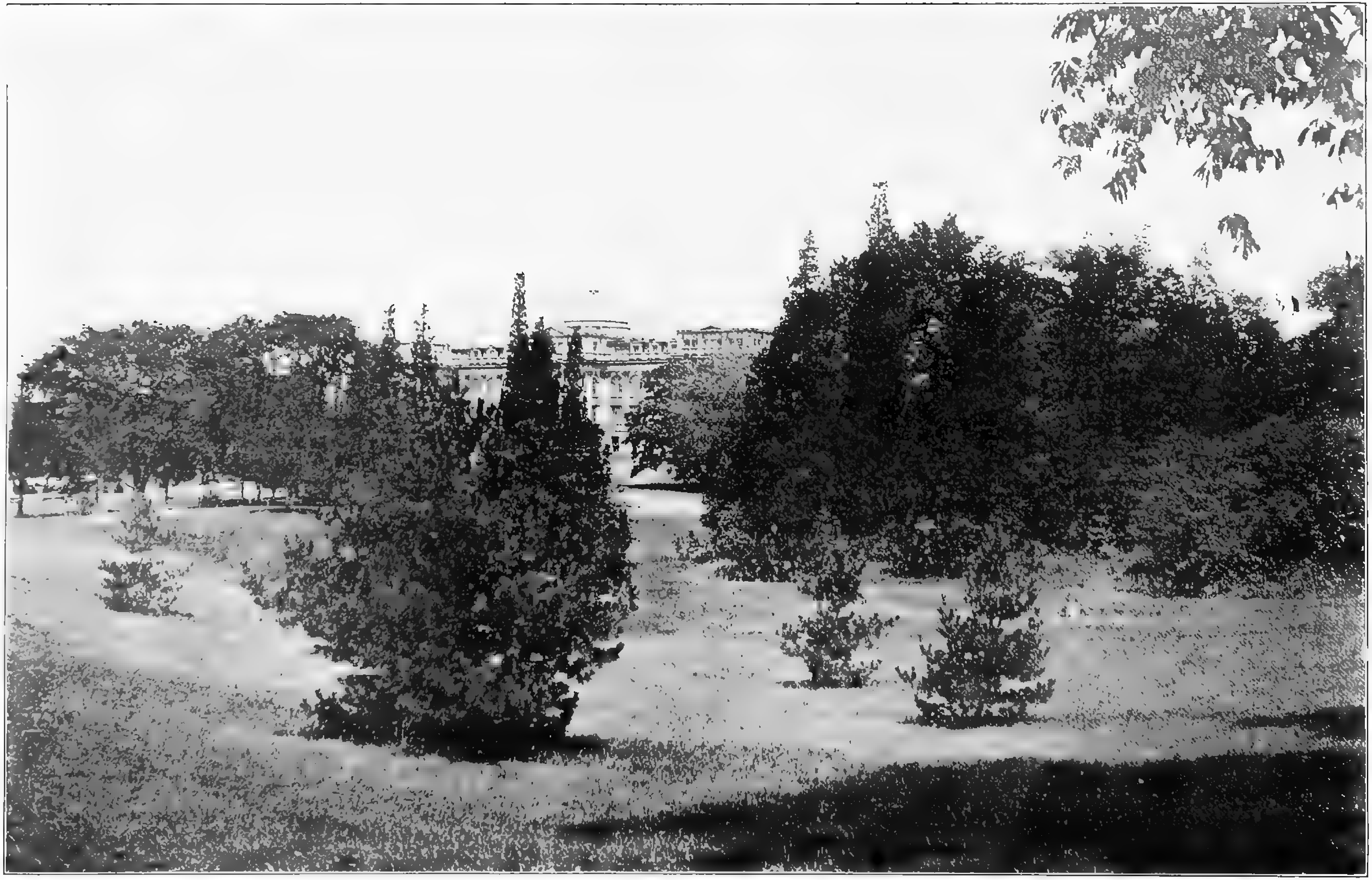
The collection of cone-bearing trees, technically known as the Pinetum, because the pines are the most abundant of these trees, is planted over a space of about 30 acres in the southwestern part of the grounds, extending from the approach to the elevated railway station southeast to the herbaceous garden, and northeast to the museum building and the borders of the hemlock forest. The species of trees are grouped in genera, as shown by the accompanying plan. The planting out of these trees was commenced in 1901, and, as rapidly as the finished grades of this portion of the grounds have been established and the driveways and paths completed, additional planting has been done; the collection will continually become more complete year by year as additional species are secured; many of these have to be raised from seed, and the process of establishing a collection of conifers thus requires much time.

Commencing at the approach to the elevated railway station we find the Douglas spruce (*Pseudotsuga mucronata*) planted in the space between the traffic road and the park driveway to the left of the path leading to the Conservatories; this tree is a native of western North America from the Rocky Mountains to the Pacific Coast and is sometimes known as red fir. In the far northwest it sometimes becomes 180 to 210 feet high, its trunk occasionally as much as 3½ feet in diameter, but in the Rocky Mountains it is seldom one-half this size, and trees taken from the far northwest do not thrive well on the Atlantic coast, owing to the much greater rainfall which they naturally receive there; the cones of the Douglas spruce are from 2 to 4 inches long, pendant on the branches, their scales rounded and shorter than the bracts which project beyond them.

The hemlock spruces (*Tsuga*) are planted between the approach to the elevated railway station and the power house, and are represented by the Canadian hemlock spruce (*Tsuga canadensis*), the same species which forms the interesting forest on the hills bordering the Bronx River, and indicated on the general plan of the Garden as the hemlock grove. This tree occasionally becomes about 90 feet high, with a trunk up to 12 feet in diameter, and is distributed throughout northeastern North America, extending southward along the mountains to Alabama, northward to Nova Scotia and westward to Minnesota. Its bark is the most important tanning substance in the United States and a great many trees are annually felled to obtain it; its wood furnishes a cheap lumber of little strength and durability. The Carolina hemlock (*Tsuga caroliniana*), from the mountains of southern Virginia to Georgia, may also be seen here, as well as the Japanese hemlock spruce, to which the name *Tsuga* was first applied.

In the area to the westward of the conservatories, and bounded by the surrounding paths, are the firs (*Abies*). These can at once be distinguished from the spruces (*Picea*) by the erect, instead of pendulous, cones, and by the smooth branchlets. The wood of the firs is usually soft and not durable, so it makes poor lumber. Specimens of the balsam fir will be found here; this is widely distributed over northern North America, and from it is obtained canada balsam or balm of fir, used in the arts and in medicine. The Japanese silver fir is an attractive plant, with its dark green stiff foliage. Veitch's silver fir, from Japan, and said also to occur on the neighboring coast of Manchuria, is one of the best for ornamental purposes. It was discovered in 1860 on the famous Japanese mountain, Fuji-yama, by Mr. Veitch, for whom it is named. The red fir, from Washington and Oregon, with its blue leaves, borne almost erect and apparently on but one side of the branchlets, makes a conspicuous object. In its native country it sometimes attains a height of 250 feet. Its wood is sometimes used in the interior finishing of buildings. Among other firs here are: the white fir, from western North America, sometimes growing to a height of 200 to 250 feet; the Siberian fir, from northern Europe and Asia, yielding a soft lumber in general use and a bark used in tanning leather; the common silver fir, from Europe; Nordmann's silver fir, from the Caucasus; the Sicilian silver fir, from Asia Minor; and the Nikko silver fir, from Japan.

The spruces (*Picea*) are located in the area to the northeast of the firs. Some of the spruces are most valuable timber trees. The oriental spruce, from Asia Minor, is present in several specimens. One of the hardiest spruces for our climate, and a general favorite, is the Colorado, or blue, spruce, the young foliage of which has a decided blue color, whence its name. It usually grows about 100 feet tall in its native country. The Norway spruce, with a number of horticultural forms, makes a group on the highest portion of the area devoted to the spruces and is a commonly cultivated tree. It furnishes a useful timber, which is known as "white deal" in England, and is largely used in the manufacture of musical instruments. The resinous exudation of this tree is known as Burgundy pitch, which, in combination with other ingredients, is used in Germany to line beer casks. Other spruces of interest here are the Yesso spruce, the wood of which is much used in Japan; the white, or Engelmann's, spruce, from western North America, the wood of which is largely manufactured into lumber and the bark sometimes used in tanning; the Servian spruce, one of the largest and most valuable timber trees of Europe; and the tiger's-tail spruce, from Japan,



VIEW IN THE PINETUM. THE MUSEUM BUILDING IN THE DISTANCE introduced about forty years ago, and one of the hardiest Asiatic species in cultivation.

The space allotted to the pines (*Pinus*) embraces the region to the eastward of the spruces and public conservatories, extending across the road to the herbaceous grounds. Most of the pines are of great economic importance, furnishing large quantities of lumber, turpentine and resin. Most of the white pines will be found on the westerly ridge of the herbaceous grounds and across the road from this to the eastward of the conservatories. Among these is our common white pine and several of its horticultural varieties. It is perhaps the most valuable of the timber trees of northeastern North America, large quantities of lumber being derived from it; near this is the Himalayan pine, resembling it, but with longer leaves. This sometimes attains a height of 150 feet in its native country, where its lumber is much used for building and other purposes. In this region will also be found the Cembra or Swiss stone pine, of southern Europe and northern Asia; and the Macedonian pine, of southeastern Europe.

In the area to the eastward of the conservatories will be found, among others, the Corsican pine, with a hard, strong wood which is much used; the variegated Scotch pine, with the young leaves variegated; and a number of plants of both the white pine and Himalayan pine.

In the region to the north of the white pine tract, and on the westerly side of the herbaceous grounds ridge, will be found the Tyrolese mountain pine, from the Tyrolese and Venetian Alps, forming a group of some dozen plants; near this is the Japanese red pine, and two horticultural forms of it, from Japan. Following these to the north are a number of plants of the Jack pine, or Banks' pine, native of northern North America. Its wood is sometimes used for fuel, and was valued by the Indians for the frames of their canoes.

In the area to the eastward of the spruces are a number of other pines. The Corean pine, one of the white pines and a native of eastern Asia, is located next to the spruces. Near this is the Table-mountain pine. On the high ground to the eastward of the above is the Scotch pine, the principal timber pine of Europe and Asiatic Russia. On the easterly slope of this higher land and on the lower ground nearby may be found, among others, the red or Canadian pine, from northeastern North America, the wood of which is largely used for building purposes and for masts, piles and spars; the small-flowered pine, another of the white pines and from Japan, where it is frequently used by the Japanese in producing their miniature trees; the Japanese black pine, also from Japan and useful for its wood; the Austrian pine, found native in Austria, Servia and Roumania; and the yellow, or bull, pine, from western North America.

In the triangle located midway between the south gate and the conservatories, are the American cypresses (*Taxodium*), in two species: the cypress, or bald cypress, and the pond cypress. These, like the larches (*Larix*), and a few other coniferous trees, shed their leaves for a portion of the year. They form vast areas, in parts of the southern states, called cypress swamps. Their timber is of economic importance and their bark is rich in tannin. None of the true cypresses (genus *Cupressus*) are hardy with us.

At the northern end of the swale in which the herbaceous grounds are located, is a miscellaneous collection of coniferous trees, and also the members of the yew family (Taxaceae). Among the miscellaneous coniferous trees here are: the Japanese cedar, a tree which is barely hardy in this latitude; the umbrella pine, from Japan, a very decorative plant; the deodar, or Indian cedar, from the Himalayan region; and the Mt. Atlas cedar, from northern Africa. The larches (*Larix*) may also be found in this neighborhood, on the ridge. These are deciduous trees, the wood of which is of great economic importance. Specimens of the European larch are here, and also of the Japanese larch. The genus *Pseudolarix,* distinguished from the larches in having the scales of the cones deciduous, is represented by its single species, the golden, or Chinese, larch; this, like the true larches, is a deciduous tree.

The yew family (Taxaceae) is represented by two genera. Of the true yews (*Taxus*), there are: the American yew, or ground hemlock; the English yew and several of its horticultural forms, the wood of which was highly prized in ancient times for the manufacture of bows; and the Japanese yew. The cluster-flowered yew (*Cephalotaxus*) is represented by Fortune's cluster-flowered yew, from northern China, and the iraga boku, of the Japanese, from Japan. Other representatives of this group will be found in conservatory houses Nos. 12 and 13.

On the westerly corner of the conservatory terrace and in the immediate vicinity are located the retinisporas, which are so commonly cultivated as decorative plants. There are many horticultural forms here represented, but they are all variations of two Japanese trees: the Sawara cypress (*Chamaecyparis pisifera*); and the Hinoki cypress (*Chamaecyparis obtusa*). The latter species is frequently used by the Japanese in their dwarfing process. The names borne by the various horticultural forms have been suggested by some peculiarity in coloring or in manner of growth. Other species of the genus *Chamaecyparis* will be found in the low ground along the south walk, not far from the south gate.

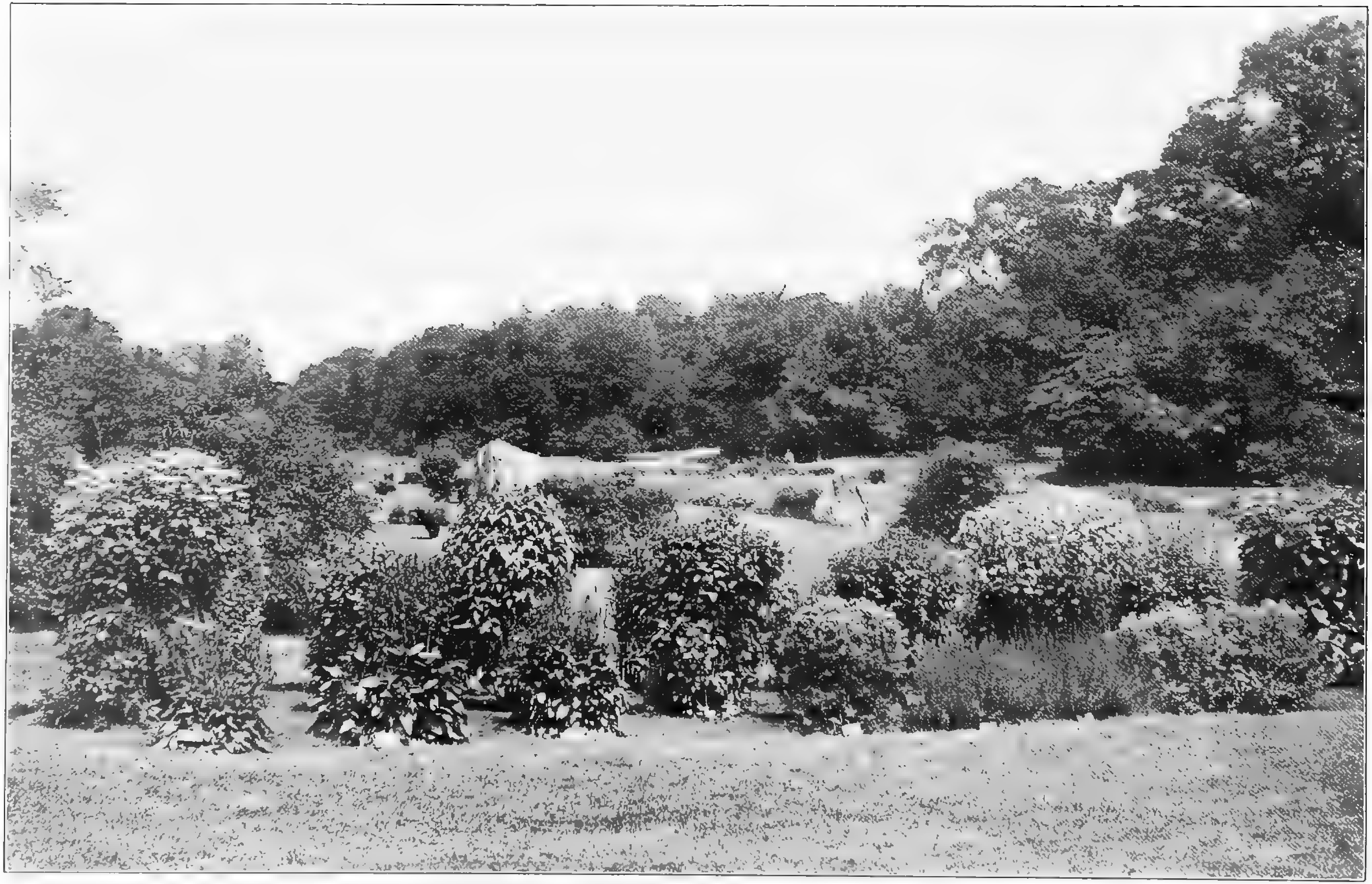
On the easterly corner of the conservatory terrace, opposite the retinisporas, is a part of the juniper, or red cedar (*Juniperus*), collection. The remaining and larger portion of this collection will be found on the easterly end of the area lying between the driveway and the traffic-road south of the conservatories. In these two regions will be found many species and varieties of these plants. The common juniper, of north temperate regions, is one of these; also the Irish juniper, a form of this, of compact and strict habit. The red cedar, so common in a wild state in the grounds of the Garden, finds representatives in many horticultural forms. The low cedar, of North America, Europe and Asia, is a pretty dwarf species. The savin juniper, of Europe and northern Asia, and its American representative, the prostrate juniper, of northern North America, are both neat low-growing sorts. The Chinese juniper, and its striking form, of columnar habit, known as variety *pyramidalis,* are each present in a number of specimens. There are still other varieties of the Chinese juniper represented her.

At the westerly end of this same area is the arbor vitae (*Thuja*). The species of this genus produce a durable wood, which is of especial value where there is contact with the soil. The Japanese arbor-vitae is represented by a single specimen. The common arbor-vitae, or white cedar, from northeastern North America, is fully represented, not only by the typical form, but by many horticultural varieties, some of them very decorative. The wood of this tree is valued for fence posts, railway ties, etc., and from its young branches fluid extracts and tinctures are made which are used in medicine. The Chinese arbor vitae, from China and Japan, has a number of specimens representing it and some of its horticultural forms.

The maiden-hair tree family is represented by a single species, the maiden-hair tree, several specimens of which may be found on the southern portion of the westerly ridge of the herbaceous grounds. This interesting tree, with its fan-shaped leaves, is a remarkable relic of a type of vegetation which was common and widely distributed in tertiary geological time, but is now restricted to eastern temperate Asia in this one species, *Ginkgo biloba.*

4. The Herbaceous Grounds

The collection of hardy herbaceous plants is situated in a valley southeast of the public conservatories, and between the main driveway and the western border of the woods fringing the hemlock grove. This valley is about 500 meters long and averages about 100 meters wide. A small stream runs through the valley from north to south and is here and there broadened out into pools. The collections are arranged



VIEW IN THE HERBACEOUS GROUNDS

in four series: (*a*) The systematic plantation; (*b*) the morphological garden; (*c*) the economic garden; (*d*) the viticetum, or collection of vines, both woody and herbaceous, planted at an arbor just east of the northern part of the valley.

(*a*) SYSTEMATIC PLANTATIONS

This is located in that portion of the valley south of the driveway crossing it, and here the plants are grouped by natural families in botanical relationship. To the east of the brook are the seedless plants, represented by the ferns and their allies, and the families of seed-bearing plants belonging to the large endogenous division, or those with parallel-veined leaves and with one seed-leaf (monocotyledons). To the west of the brook are the families belonging to the exogenous division of plants, or those in which the leaves are usually net-veined and which have two seed-leaves (dicotyledons). This latter group embraces the larger part of the plants in the collection. Along the brook, or in it, may be found many aquatic plants, representing in some cases families which are exclusively water-lovers, while in other cases they are aquatic representatives of families occurring in the immediate vicinity in the beds. In this plantation, the family groups are arranged substantially in a sequence beginning with those of simpler organization and proceeding to the most complex.

The series commences in the southern corner of the valley at the foot-path entrance, where the hardy ferns and their allies may be found, including species from all parts of the north tepmerate zone. Among these may be mentioned the ostrich fern, the cinnamon fern, Clayton's fern, the royal fern and the American royal fern, the brake or bracken, and a number of species of the shield-ferns and of the spleenworts. A collection of forms of the lady-fern, representing many variations, may be found here also. Some of the aquatic representatives of the ferns and their allies may be found in the pond nearby.

In this pond may also be found the following aquatic endogenous families: the cat-tail family, the bur-reed family, the pond-weed family, the arrow-grass family, and the tape-grass family. At the junction of the brook with this pond is the water-plantain family, including, besides the water-plantain, several species of arrow-head (*Sagittaria*). A little beyond, in the brook, may be found the water-poppy family, represented by the water-poppy, a showy plant common in tropical regions.

Following to the north comes the large group of the grasses and grass-like plants, those whose flowers, mostly very small, are subtended by chaffy scales or glumes. This is represented by the grasses and the sedges, several beds being devoted to each of these familis. Some of the more familiar grasses are: timothy, Kentucky blue-grass, reed canary-grass, orchard grass, red-top and tall fescue-grass, all used in making hay. Other grasses of interest are: sweet vernal-grass, exhaling a pleasant odor when bruised; the Japanese plume-grass, in several forms, very ornamental; the ribbon-grass, a variegated form of the reed canary-grass, and also ornamental; and species of many other genera.

The sedges are represented mainly by the large genus *Carex,* perhaps the most striking of which is Fraser's sedge, from the southeastern United States, at one time one of the rarest of plants, but rediscovered in recent years in large quantities in the mountains of North Carolina. The tussock sedge, common in our swamps in early spring, the cat-tail sedge, Gray's sedge and the fox sedge, are others belonging to this genus. There are also representatives of bullrushes and other sedges.

Following the sedges is the arum family, having as representative plants, familiar to many, the skunk cabbage, the green arrow-arum, the green dragon, the jack-in-the-pulpit, and the sweet flag. In the brook opposite to this family may be found the somewhat related duckweed family; the duckweeds (*Lemna*) are very common, these tiny plants sometimes occurring in such numbers as to cover the surface of ponds and slowly moving streams. Along the edge of the brook just beyond is the yellow-eyed grass family, and near it the pipewort family. Coming now to the spiderwort family, we have represented mainly the spiderworts and day-flowers. In a small pool and along its eastern edge is placed the pickerel-weed family. Here may be found a large clump of the pickerel-weed (*Pontederia*) which is so common in swamps and along streams in the vicinity of New York; here may also be found the water-hyacinth, which has become such a pest in some of the rivers of Florida and the West Indies, and the closely related blue water-hyacinth, of more straggling habit, also of tropical origin.

The rush family occurs next in the sequence, represented, among others, by such familiar plants as the common bog-rush, the slender rush, and the common wood-rush. Following this come the members of the bunch-flower family, with several species of bellworts, the turkey-beard, the Japanese toad-lily, the fly poison, the swamp pink and others. Closely related to this is the lily family. One of the beds given over to this family is devoted to the true lilies (*Lilium*) in several forms; another is set aside for the onions and their relatives, of which there are many interesting forms, some of them of decorative value; while another bed is given to a miscellaneous collection of plants belonging to this family, among which may be mentioned the day or plantain lilies, the yellow day lilies and the lemon lilies, the true asphodel or king's sword, the grape-hyacinth and Adam's needle. Other close relatives of the lilies belong to the lily-of-the-valley family; here may be found many familiar plants, among them being the lily-of-the-valley (*Convallaria*), the wild spikenard, the common asparagus, of such wide use as a vegetable in the early part of the summer, and several species of the Solomon's-seal, both from the Old World and the New.

The amaryllis family is shown by a number of species of daffodils and narcissus. In the iris family, which comes next, many species are represented. Most familiar among these are: the common blue flag of our swamps, the yellow flag of Europe, the German iris, the Siberian iris, the Japanese iris and the blackberry lily. For the canna family reference is made to the plantations at the Garden fountain at the approach to the museum building and to the conservatories, and for orchids to the conservatories.

Crossing the brook now by the path paralleling the driveway, we come to the beginning of the sequence of the large series of plants with net-veined leaves and with two seed-leaves (dicotyledons). This series begins with the lizard's-tail family, represented here in the brook by the lizard's-tail (*Saururus*), a common plant of our brooks and river borders in the eastern United States. To the nettle family one bed is at present given, located near the group of magnolia trees, where may be found, among other kinds: the slender nettle, of North America; the stinging nettle, native in Europe and Asia, but introduced into this country; and the wood nettle, also a North American plant; all of these secrete an oil through the hairs covering the stem and leaves, this oil being irritating to the skin, especially in the stinging nettle. In the immediate neighborhood and to the right is the birthwort family, represented by several species of wild ginger (*Asarum*), among them the common one of this region, the short-lobed wild ginger, the root of which is of medicinal value; another is Shuttleworth's wild ginger, of the southeastern United States. To the buckwheat family there are at present devoted three beds, forming a group to the left of the nettle family. The docks (*Rumex*) are shown in many forms, as are the knotweeds (*Polygonum*); the most showy of these are the Japanese and Sakhalin knotweeds, the latter a plant of considerable economic importance, being used as a fodder plant, and is a native of the Sakhalin Island; to this family also belong rhubarb, or pie-plant, and buckwheat. Next to this and near the brook is the goosefoot family, with several species, one of which, the lamb's-quarters (*Chenopodium*), is native of Europe and Asia, but found as a common weed in waste places and along roadsides in this country; its young shoots are sometimes used as a vegetable. Closely related to this, and just south of it, is the amaranth family, represented by several species of the pigweed, many of them among the commonest weeds of our roadsides and waste places. Forming a series to the right of this are: the four-o'clock, pokeweed, carpetweed and purslane families. In the four-o'clock family may be found the common four-o'clock of our gardens, a native of tropical America, its flowers opening only on cloudy days or late in the afternoon on clear days, whence its name; and the umbrellaworts, from North America. The pokeweed family is represented by the common poke or garget (*Phytolacca*), native of the eastern part of North America, a plant of medicinal value and poisonous, but its young shoots when first appearing above the ground are sometimes used as "greens." In the carpetweed family are the carpetweed, from which the family derives its name, a native of the United States and Mexico, but a common weed in this vicinity; and representatives of the south African fig-marigolds (*Mesembryanthemum*), many of them very showy; they are not hardy in this latitude and must be planted out every spring. In the purslane family, among others, may be found the sunplant or common portulaca of the gardens, a native of South America; the small-flowered talinum, from the central United States; and the common purslane or pusly, a pernicious weed in many sections of the country, and often used for "greens" or as a salad.

The pink family follows, with three beds. Many kinds of pinks, catchflies, chickweeds and gypsophils may be found here. In the first pool, formed by the widening of the brook, is the water-lily family; the large yellow pond lily or spatterdock, a native of eastern North America, may be found here, as may also its relative, the red-disked pond lily, from northeastern North America; the small white water-lily, a native of northwestern North America and Asia, the European water-lily, from Europe and Siberia, and the sweet-scented water-lily, and its variety, the pink, or Cape Cod, water-lily, also find a place here; the water-shield or water-target is also a member of this family and a native of North America. The tanks in the court of the public conservatories contain a great many additional kinds. The hornwort family likewise occupies a position in this pool. The aquatic members of the crowfoot family are grown here, the terrestrial forms being placed in four beds to the westward; one of these beds is given up entirely to the peonies (*Paeonia*), of which there are a number of interesting and handsome forms, and in the other beds may be found larkspurs, columbines, buttercups, meadow-rues, anemones, liver-leaf, and many other relatives; aconite, or monk's-hood, of great medicinal value, also belongs to this family.

The barberry family, which is represented by a single bed on the ridge to the right of the crowfoot family, contains, among others, the blue cohosh and the may-apple or mandrake (*Podophyllum*), natives of North America; the twin-leaf, a native of the northeastern United States; and the Japanese plants, the two-leaved aceranthes and the red epimedium. In the poppy family may be found the oriental poppy, a native of Asia Minor and Persia, and here may be seen also the cordate bocconia, from Japan, and the Mexican poppy, a native of Mexico and found as a weed in many tropical and warm temperate regions. In the fumitory family are the bleeding-hearts (*Bicuculla*), represented by the wild bleeding-heart from the eastern United States. The mustard family, which comes next in the sequence, occupies two beds. To this family belong the candy-tufts, represented here by the evergreen candy-tuft, from southern Europe and Asia Minor, and the alpine rock-cress, from Europe and North America, one of the showiest flowers in early spring, its mantle of pure white flowers making it a conspicuous object; there are many other species represented in this group. The caper family has as representatives the showy pedicellaria, a native of the Old World, and the clammy weed (*Polanisia*), from northern North America. The white and yellow cut-leaved mignonettes (*Reseda*) represent the mignonette family. Across the path to the right, on the ridge and partly surrounding a rocky knoll, is the bed devoted to the orpine or stonecrop family, where there may be found many of the stonecrops (*Sedum*), among the more showy and attractive being: the great purple stonecrop, the great stonecrop, the white stonecrop, and the mossy stonecrop, all natives of Europe and northern Asia; the wild stonecrop and Nevius' stonecrop, both from our own country; the Siberian stonecrop and the poplar-leaved stonecrop, both from Siberia; and a Japanese species, Siebold's stonecrop; also belonging to this family are the houseleeks (*Sempervivum*), of which there are many representatives, all from the Old World, however, as these plants are not indigenous to the New World. Many other species of this family, not hardy in this latitude, may be found in the conservatories. Across the path from the orpine family may be found the three beds devoted to the saxifrage family. The heart-leaved saxifrage, with its large, thick leaves, from Siberia, is one of the showiest plants here, sending up its large masses of pink flowers early in the spring, so early sometimes that they are nipped by the frost. Among other plants here may be mentioned: the alum-root, from the eastern United States; the two-leaved bishop's-cap, from the northern United States; the Japanese plant, *Rodgersia;* and the shield-leaf saxifrage, from the western United States. Menzies' saxifrage, from western North America, is interesting from the fact that in late summer and fall it produces small plants at the base of the leaf-blades.

To the herbaceous members of the rose family are allotted five beds, located to the left of the saxifrage family. Many species of cinquefoils and agrimonies may be found here; of the strawberry (*Fragaria*) there are several species represented; the lady's-mantle, from north temperate regions, the various species of avens, the goat's-beard, the burnets and many others, are of decorative value or of interest for other reasons. The roses, blackberries and raspberries, also members of this family, are shrubs, and may be found at the fruticetum. The mimosa family has relatively but few representatives in temperate regions, most of its numerous members being confined to warm temperate regions and to the tropics; many of these may be found in the conservatories.

To the senna family belong the sennas or cassias, a showy representative being the American senna, a native of North America; this family being also largely of warm temperate and tropical distribution, many other species may be found in the conservatories. To the right of the mimosa family may be found the bed devoted to the pea family; to this some of our most valued economic plants belong, such as the pea, the bean and the clover; to the pea family belong also the baptisias, the bush-clovers, the vetches, the tick-trefoils and many other familiar plants.

Next in the order of sequence is the geranium family, to which belong the geraniums or crane's-bills; the plants so often cultivated in the house under the name of geraniums, but which are not hardy out of doors in our climate, are really not what they are called, but are truly pelargoniums, a closely-related group of plants belonging to the same family; besides our common wild geranium or crane's-bill may be found, among other plants here. A little farther on, near the brook, may be found the bed devoted to the wood-sorrel family, often called sour-grass by children; several species are shown here. Just to the left of the geranium family is the flax family, to which belongs the flax plant (*Linum*), from the fiber contained in the stem of which linen is made. Beyond this is the bed for the rue family; to this belong the common rue, of southern Europe, and the fraxinella; this family also includes the oranges and lemons, specimens of which may be found in the conservatories, and a very great number of tropical trees and shrubs. To the right of this is a small bed devoted to the milkwort family. The spurge family is in a bed just to the left of the flax family; the flowering spurge, from the eastern United States, and the cypress spurge, from Europe, but sometimes found wild in this country as an escaped plant, are both here. Along the edge of the brook, and opposite the spurge family, may be seen the water-starwort family, to which belong a number of small aquatic plants. About opposite this, and at the base of the rocky ridge to the right, are two representatives of the box family, in the trailing pachysandra, from North America, and its Japanese relative, the terminal pachysandra; the true box (*Buxus*) is a shrub or small tree, native of Europe, and several specimens of it may be found at the fruticetum. A little to the right of the wood-sorrel family is the jewel-weed family, to which belong the common balsam of the gardens, and the plant so common along our brooks and other wet places, and known as jewel-weed, or touch-me-not. A little beyond this are three beds of the mallow family; the hollyhocks belong here, as do the mallows; the crimson-eye mallow and the swamp-rose mallow, both from North America, are showy representatives of this family; and the marsh mallow, a native of Europe and the Orient, is also shown; its root is used in the manufacture of a mucilage and for medicinal purposes.

To the right of the mallows is the bed given over to the St. John's-wort family. The rock-rose family comes next, a little further on; here belong the rock-roses of Europe and our own frost-weeds. To the right of this is the violet family; a large collection of our native species, together with some from foreign lands, is here brought together and many of these may be recognized as old friends. Up on the ridge to the right, across the walk, may be found the cactus family; relatively few of these are hardy in this climate, so the larger part of the cactus collection must be sought in the conservatories. Here may be found, however, several representatives of the prickly pears (*Opuntia*), including the eastern prickly pear, common in this part of the country, which is frequently found on the rocky ridges in the vicinity of New York and occurs wild on some ledges within the Garden reservation. Down near the brook, and not far from the mallow family, is the loosestrife family, represented by the purple loosestrife, a native of Europe, but introduced in many places in this country; among others belonging to this family is the swamp loosestrife, or willow-herb (*Decodon*), a plant of which may be found along the brook opposite to the loosestrife bed. Near this, on the edge of the brook, is located the meadow beauty, one of the prettiest little flowers of our meadows. It belongs to the meadow-beauty family, few species of which occur in cool regions; it is largely represented in warm temperate and tropical regions, and many other species may be found in the conservatories. But a short distance from the violet family is the evening-primrose family; here may be found a number of the evening primroses (*Oenothera*), with their showy yellow flowers, noteworthy as the plants mainly experimented with by Professors DeVries and MacDougal in their studies on the origin of species. Along the brook, not far from the loosestrife family, is the water-milfoil family, represented by the Chilean water-milfoil or parrot's-feather, forming a beautiful mass of feathery green on the surface of the water. Returning now to the ridge, a little beyond the violet family, we find the bed allotted to the ginseng family; here are the Indian-root, from eastern North America, and the heart-leaved aralia from Japan. To this family also belongs the ginseng plant, the root of which is so much prized by the Chinese as a medicine. Down the slope from this group may be found two beds given over to the carrot family, which includes many economic plants, such as the carrot, parsnip, celery and caraway; lovage, a common European plant, is shown, and the rattlesnake-master, from the eastern United States; the wild carrot and the golden meadow parsnip also belong here.

To the primrose family, located at the base of the ridge a little beyond the carrot family, belong the primroses (*Primula*), many of which are natives of Europe; here we find the common European primrose, the cowslip and others; the moneywort, a native of Europe, but introduced into many places in this country, sends it long creeping stem all over the bed—this is sometimes known as creeping Charlie; the fringed loosestrife, from North America, is also here, as is the clethra-like loosestrife, from Japan, with its racemes of white flowers. Between the two beds devoted to the carrot family, and a little beyond, is the plumbago family, to which belongs the common thrift of Europe; there are several other thrifts here also, as well as the statices or sea-lavenders, in several species. The bed allotted to the gentian family may be found a little beyond the plumbago family; various gentians are represented, among them the blind gentian, a native of the United States, and the Thibet gentian, from the Himalayas and China. In the brook, just beyond the little stone bridge, may be found the buckbean family; here are shown the water-snowflake, common in tropical regions, and the water-lily floating heart, native in Europe and northern Asia.

Just beyond the left hand bed devoted to the carrot family is the dogbane family; the willow-leaved amsonia, from the central and southeastern United States, and the broad-leaved amsonia, from the central and eastern United States, are conspicuous objects here. Beyond this are two beds of the milkweed family and among its representatives are the common milkweed of our roadsides, the hairy milkweed and the swamp milkweed; the swallowworts also belong here and are illustrated by several species. In the morning-glory family, located to the right of the above, are the small bindweed, of northern Europe and Asia, sometimes a troublesome weed in this country, and the bush morning-glory from the western United States. Following the milkweeds is the phlox family; interesting plants here are the Jacob's-ladder (*Polemonium*), of Europe, with its masses of blue flowers; the hairy phlox, of North America; Britton's phlox, a relative of the common ground phlox, from the southeastern United States; the ground phlox and its white-flowered form, both natives of the eastern United States; and forms of the garden phlox, also from the southeastern United States. In the shade, the natural habitat of many of these plants, is the water-leaf family, at the base of a large rock on the ridge; there are the purple, the broad-leaved and the Virginia water-leaf (*Hydrophyllum*).

Further along and at the base of the ridge is the borage family; the tuberous comfrey, the rough comfrey and the common comfrey, all natives of Europe, are represented. In the vervain family, in a small bed to the left, may be found:

the wedge-leaved fog-fruit (*Lippia*), from the western United States and Mexico and the vervains. We now come in the sequence to the mint family, to which are devoted six beds; among the true mints may be found here the creeping whorled mint, the curled mint and the spearmint, all from the Old World. Many familiar plants may be seen in these beds, and among them are: the false dragon-head, of the United States; motherwort, common in Europe and widely distributed as a weed in this country along roadsides and in waste places; the horse-balm, of North America, common in the east in woods; Oswego tea, and other bergamots, natives of North America; the betony and hyssop, of Europe; the hedge-nettles, from both the Old World and the New; the common sage of the Mediterranean region, highly prized by the housewife, and other sages; catnip, a native of Europe, but widely distributed as a weed in this country; Gill-over-the-ground, or ground ivy, also a European plant, but extensively spread as a weed in this country; and the dittany, of North America.

The potato family may be found a little to the left and just beyond the phlox family. Here may be seen the common jimson, or Jamestown, weed, the seeds of which are poisonous, a native of tropical regions, but a common weed along our roadsides; the nightshade, a European plant, but commonly distributed as an introduction in many parts of this country, also with poisonous fruit; tobacco plants and solanums; it is to this family that the potato, tomato and eggplant belong. A little beyond and to the left of the mints are the two beds allotted to the figwort family; of interest here are: the beard-tongues, of which there are several species; the speedwells (*Veronica*), among them the long-leaved speedwell and the gentian speedwell; the fox-gloves (*Digitalis*), from one of which, the purple fox-glove, the valuable medicine digitalin is derived; Lyon's snake-head from the southern states; culver's-root, from the southeastern United States; and several figworts. Just beyond this may be found the unicorn-plant family, represented by the unicorn-plant.

A little beyond is the globularia family, represented by a single species of globularia. To the right is the acanthus family; not many of these plants are hardy in this latitude, but in the conservatories many representatives may be found, as the family is largely confined to tropical and warm temperate areas; in this bed may be seen the hairy ruellia, from the southeastern United States. In this neighborhood may also be seen the lopseed family, represented by the lopseed, a native of eastern North America.

To the right of the acanthus family is the single bed devoted to the plantain family; several species, such as Rugel's plantain and rib-grass, are pernicious weeds in this neighborhood, often disfiguring an otherwise even lawn. Just beyond the mints may be found the two beds of the madder family; to this belongs the dainty little bluets or innocence, which sometimes give a blue sheen to sterile, sandy places, so abundant is it in some localities; it is quite common in eastern North America; several species of bedstraw (*Galium*) may also be found here, while many other plants belonging to this family are grown at the conservatories, among them the coffee tree. A little beyond is the single bed of the honeysuckle family, represented by the feverworts; this family being large composed of woody plants, many other species, including the true honeysuckles, may be found in the fruticetum and in the viticetum. To the left is the valerian family with a single bed; here may be found the valerian, a common European plant.

Just beyond the plantain family is the teasel family. It is to this that the teasel plant belongs, used in olden times for raising the nap on woolen cloth. Several species of cephalaria may be found here. The bell-flower family is a little further on and to the left; the Carpathian and Host's bell-flowers, both natives of Europe, are pretty representatives here; the creeping bell-flower, or Canterbury bells, also a native of Europe, may be found here in several forms; the Japanese bell-flower and its white variety are also here, their large showy flowers making them quite conspicuous. A little further on and to the left is the lobelia family; the cardinal flower and the blue cardinal flower, both natives of North America, make showy objects; the former is particularly striking in its rich masses of cardinal-red flowers.

To the right of the teasel family is the chicory family. The common lettuce (*Lactuca*), so much used in salads, belongs here; many of the plants are extremely weedy by nature, and this is particularly true of the hawkweeds, a genus richly represented in the Old World, several species of which are shown here; the oyster plant is also a member of this family.

To the left of this may be found the ragweed family. All the species here are of a weedy nature. The ragweed, the giant ragweed and the common clot-blur find representation here. Terminating the sequence comes the very large thistle family, represented by many species from all parts of the world; there are nine beds at present given over to these plants; the sunflowers, coneflowers, thistles, asters, fleabanes, yarrows, golden-rods, tansies, sneezeweeds, burdocks, artemisias and wormwoods, cat's-foot, tick-seeds, elecampane, boneset, chrysanthemums, colt's-foot and many others are shown; the Jerusalem artichoke, one of the sun-flowers, a native of eastern North America, bears edible tubers.

(*b*) Morphological Garden

This is located to the north of the systematic collection, the two collections being separated by the driveway which crosses the valley. It is designed to illustrate here with typical examples the organs and other features of plants, including leaf-forms and the various modifications of their margins, their venation and insertion on the stem; also the various kinds of stems, methods of propagation, flower-clusters and fruits, leaf-movements, parasites, desert plants and seed-dispersal. Looking north on this collection, the first bed to the right of the brook contains plants illustrating simple leaf-forms. Immediately following this on the same side of the brook are the plants representing the various forms of compound leaves, or those in which there is a distinct jointing of the leaflets to the leaf-axis. Farther along the brook, in the pool, may be found various forms of aquatic roots, stems and leaves; and a little beyond this to the right is the bed containing plants illustrating forms of propagation.

The remaining plots of this collection are located on the left hand or westerly side of the brook. The first of these to the right is devoted to leaf-venation, and the one to the left to leaf-margins, the former illustrating the character of the veins and nerves, and the latter the toothing or lobing of the margins. Beyond this to the right is the group of plants showing the manner of insertion of the leaves on the stem; and to the left of this are specimens illustrating the various ways in which plants may form a mosaic covering on the ground. A little beyond are the examples of stem-forms. One bed is devoted to show the smaller kinds, while for the larger examples, illustrating tree, twining, root-climbing and tendril-climbing stems, specimens have been selected or placed to the left of this bed and properly labeled.

A little beyond the pool may be found the bed illustrating flower-clusters, and still further on that devoted to parasitic plants, or those deriving their nourishment from the living tissues of other plants. To the left of this and farther up the hill is the group of plants showing leaf-positions. Beyond and a little to the right are plants which are at home in desert regions, and the various means of accommodating themselves to their natural surroundings are shown. Further on to the right is the bed devoted to fruit-forms; and to the left of this, one showing various forms of seed-dispersal; those with the surface of the fruits covered with some sticky substance or curved appendages or hooked hairs or spines require the intervention of some animal for their distribution, while those with wings or with hairs attached to the seed are spread through the agency of the wind. To the right of the above are plants representing a species and a variety, and to the left of this is a bed containing plants showing species and hybrids.

(*c*) ECONOMIC GARDEN

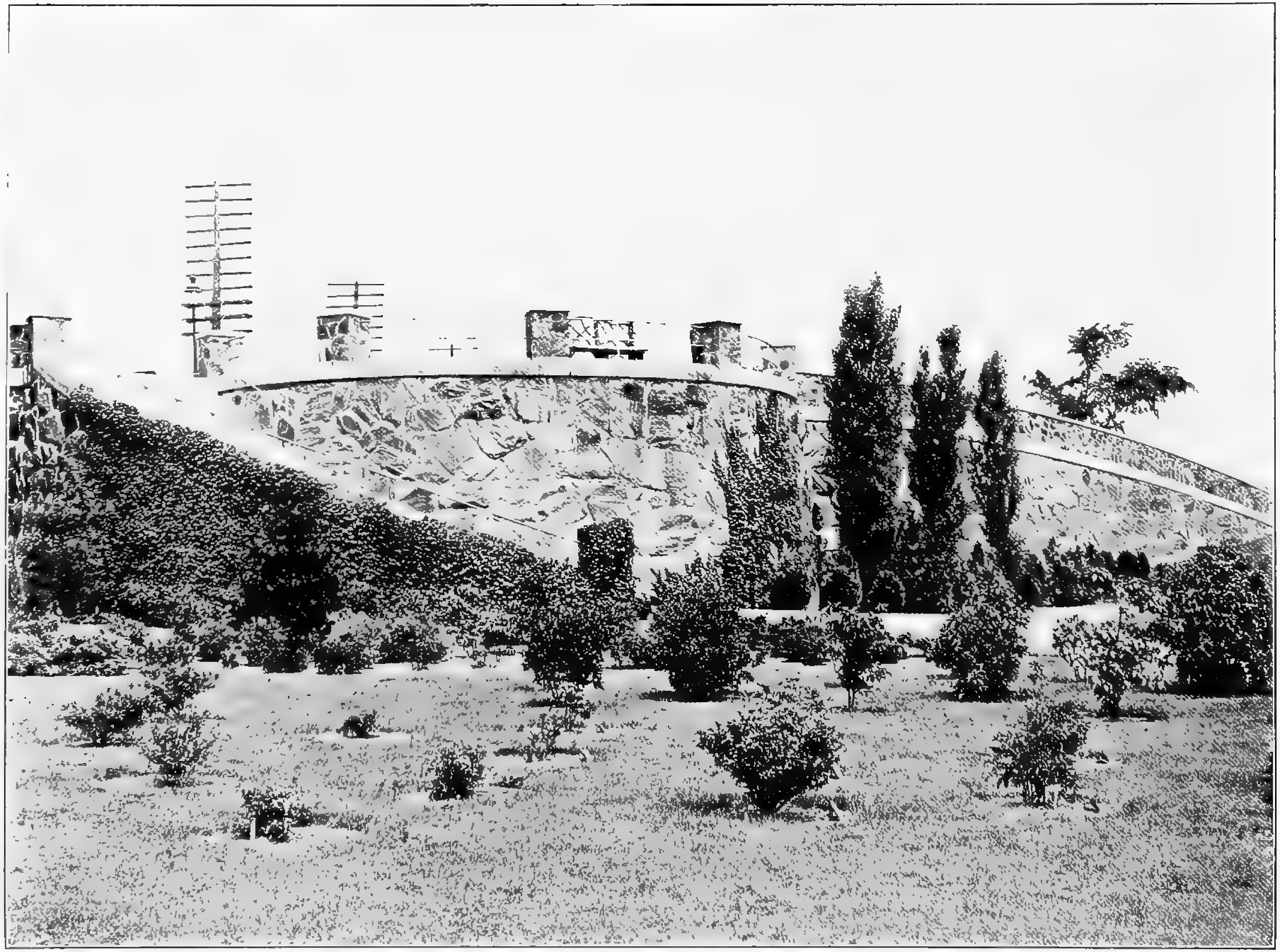
The collections illustrating food plants and those producing substances directly useful to man in the arts, sciences and industries are being installed at the northern end of the long glade containing the herbaceous collections just described.

On the east side of the broad central grass path and the brook are located plants used for medicine, those employed as condiments or relishes and a number of plants from which the fiber is used in the manufacture of various fabrics. The bed containing the plants used for condiments or relishes is at the extreme north end of the collection, while that devoted to the fiber plants is at the southern end. The remaining beds are given over to medicinal plants. The medicinal plants which grow in wet or moist situations may be found on the easterly side of the brook. Along the woodland border is also a collection of medicinal shrubs and trees.

On the west side of the grass path and brook are the food plants. Here may be found many of the common fruits and vegetables. A general sign is placed in each of the beds denoting what its contents are intended to represent, and in front of each plant is a smaller label giving individual information. Along the stone path is a collection of shrubs and trees, containing some of the more common plants producing edible nuts and fruits.

(*d*) VITICETUM

The area devoted to the plantation of vines is at the easterly side of the economic garden. Hardy vines, whether woody or herbaceous, belong here, and a rough arbor has been constructed for them to climb on. This collection is now being developed, and only a few of the species which it is intended eventually to grow there are as yet in place. The families will be referred to below in the order of their sequence. The arrangement begins at the southerly end of the arbor, on the left hand side, with the smilax family, to which belong the green-briers or cat-briers. The yam family is placed immediately opposite to the right, followed by the



APPROACH TO THE WOODLAWN ROAD ENTRANCE

mulberry family on the same side. The birthwort family, with the dutchman's-pipe as a representative, follows the smilax family on the left, and opposite to this is placed the buckwheat family, to which belong the climbing bindweeds and brunnichia. On the left hand side, and beyond the birthwort family, is the akebia family, where one may find the five-leaved akebia, a native of Japan. Following this on the same side is the moonseed family, to which belongs the Canada moonseed. On the opposite side of the arbor is the hydrangea family. The next family, occupying both sides of the arbor, is the rose family, where may be found some climbing roses. Following this, also on both sides of the arbor, is the pea family, where one must seek the peas and wistarias. Further on, occupying both sides, is the staff-tree family, where may be found the climbing bitter-sweet and other vines of this family. Succeeding this comes the grape family, to which belong the grapes, the Virginia creeper and the Japanese ivy. On the right, beyond the grape family, is the actinidia family, represented by the toothed actinidia. Opposite to this is the morning-glory family, where the morning-glories and moon-flower belong. Then comes the trumpet-creeper family, of which the trumpet-creeper, a native of the southeastern United States, is a member. This family in turn is followed by the honeysuckle family, represented here by several species of honeysuckle and woodbine. The sequence terminates with the gourd family, to which belong, as economic plants, the watermelon, cucumber, squash, muskmelon and gourds; a common vine of eastern North America, and frequent in the valley of the Bronx, is the one-seeded bur-cucumber, or star-cucumber, also a member of this family.

5. The Fruticetum

[COLLECTION OF SHRUBS]

This plantation, occupying about 16 acres, is located to the northward of the lakes in the rear of the museum building, and is confined to the area lying between the lakes, the railroad, the woodland on the east, and the north meadow. In this collection are brought together all the hardy woody plants which are shrubs, that is, plants with woody stems which branch from the ground and have no single main stem. The arrangement here parallels that in the herbaceous grounds and in the other systematic collections. The sequence begins on the southerly side near the large stone bridge which crosses the Bronx River, and proceeds on both sides of the path running to the north along the edge of the woods, returning southward on both sides of the path paralleling the main north and south driveway, to the plum family, on the bank overlooking the easterly lake. It then crosses to the senna family directly opposite and overlooking the westerly lake, proceeding northward from there across the transverse driveway, and following the line of the path paralleling to the westward the main north and south driveway. The sequence then continues to the westward along the north path, again extending southward at the Woodlawn Road entrance, continuing on both sides of the westerly path and terminating with the thistle family at the westerly end of the lake near the railroad border. The families will be referred to below in this sequence.

The pine family, represented by some of the low-growing junipers and pines, begins the sequence to the southward of the approach to the long bridge. The next is the willow family, beginning across the road from the pine family; this group is located on both sides of the path and comprises many forms from various parts of the world; the family is largely an inhabitant of temperate regions, so many species can be grown here. The bayberry family occurs across the driveway from the willows, occupying a position on the bank overlooking the easterly lake. Here may be found the sweet-fern, a native of eastern North America; the sweet gale, at home in north temperate regions; and the waxberry or bayberry, common in eastern North America; the berries of the latter have a covering of wax, which was separated by throwing the berries into hot water, when the wax melted and rose to the surface, where it was skimmed off; it is still used to some extent in making candles. The birch family follows the willows on the east side of the path; here are the hazel-nuts, the alders and the shrubby birches; the common hazel-nut and the beaked hazel-nut, both from North America, also the common hazel-nut or filbert of Europe, and others; the smooth alder, common along streams and in swamps, is also here. Following the birch family on the same side of the path comes the beech family; here may be found the shrubby oaks and the chinquapin of the southeastern United States. On the same side of the path, a little farther along, is the elm family, represented by the dwarf elms; most of the members of this family are trees and may therefore be found in the arboretum. Immediately following this is the mulberry family, represented here by two specimens of the Tartarian mulberry. At the triangle a little further on is the cercis-leaf family, represented by the cercis-leaf (*Cercidiphyllum*), a Japanese tree, and known to the people there as katzoura; there are three specimens of this, most attractive in the spring with their tender greens flushed with rose.

The crowfoot family occupies a space just to the north of the willows west of the path, and is represented by the moutan or tree peony, from China, and the shrub yellow-root (*Xanthorrhiza*), from the eastern United States; its roots are yellow, and at one time were employed as a dye; there are many herbaceous members of this family at the herbaceous grounds. The barberry family is a little farther north on the same side of the path; many species of barberries and mahonias occur here. Among the barberries may be mentioned: the common European barberry, the ripe fruit of which is sometimes made into preserves, and the unripe ones pickled as a substitute for capers—its bark is used as a dye and for tanning leather; Thunberg's barberry, from Japan, a desirable plant for small hedges and for the borders of walks; the neat barberry, from the Himalayan region, which colors a beautiful red in the fall; and the large-toothed barberry, from Nepal; the mahonias are represented by the erect Oregon grape, from northwestern North America; and the Japanese mahonia. The magnolia family occurs a little back from the path, between the crowfoot and barberry families; there are here several species of shrubby magnolias. The strawberry-shrub family follows the barberries, immediately across the path from the cercis-leaf family; here may be found several species of the strawberry-shrub, including the hairy one which has the fragrant flowers scented like the strawberry; the fragrant *Chimonanthus,* from Japan, is a member of this family, and is known to the natives there as karamume. A short distance to the eastward of the cercis-leaf family is the laurel family, represented by the spice-bush (*Benzoin*), a native of northeastern North America; as the different kinds of flowers, staminate and pistillate, are borne on different plants, only those having pistillate flowers bear the bright red berries in the summer and autumn. To the west of this is the Virginia willow family, with shrubs of the Virginia willow, a native of the southeastern United States. To the north of this is the hydrangea family; here may be found the syringas, the deutzias and the hydrangeas, several species of each; the mock orange (*Philadelphus*), a native of Europe, indicates its presence by the rich fragrance of its flowers; the slender deutzia, from Japan, bears its long slender clusters of white flowers in great profusion; the large-flowered hydrangea, a Japanese plant, bears a profusion of large bunches of white flowers, which in the late summer and autumn change to a beautiful rose color; the oak-leaved hydrangea is perhaps the oddest member of this genus; it is native from Georgia and Florida to Mississippi. Following the hydrangea family comes the gooseberry family, and to this belong the currants and gooseberries; one of the showiest is the long-flowered golden currant, from western North America; its rich yellow flowers give forth a delicious spicy fragrance. The witch-hazel family is located to the north of the north path; here is the common witch-hazel, of eastern

North America, from which the extract of witch-hazel, or Pond's extract, is made; the spiked corylopsis, a Japanese shrub, belongs here, as do the fothergillas of the southeastern United States.

The rose family occupies a large area, beginning just north of the gooseberries and currants and extending westward to the main north and south driveway, and southward along that as far as the first transverse path; here belong the spiraeas, of which there are many forms, the blackberries, the raspberries, the roses and others. Among the spiraeas, the steeple-bush or hard-hack and the willow-leaved meadow-sweet, or quaker-lady, are common as wild plants in this latitude. Other interesting forms are Thunberg's spiraea, from Japan, and other Japanese spiraeas. Among other plants of interest in the group which contains the spiraeas are the large-flowered exochorda, a native of northern China, with its profusion of white flowers in early summer; the Japanese rose, from Japan, not a true rose, however, with bright yellow flowers; another shrub from Japan, known to the natives of that country as siro yama buki, bears large white flowers resembling in appearance those of the mock orange; two other Japanese shrubs, members of the same genus, and known to the natives there as kago ma utsugi and yama doosin, respectively, the former an exceptionally graceful and attractive plant; *Neviusia,* an extremely local plant, known in a wild state only in Alabama; and the nine-bark, of eastern North America. To the southward of the spiraea group comes the collection of blackberries and raspberries (*Rubus*) represented by many kinds; two of the showiest are the Japanese wineberry and the purple flowering-raspberry, the latter common in rocky woods in this part of the country. Farther to the south, and bordering both sides of the transverse path, is the group of the true roses; many kinds may be found here, including the sweet-brier, the dog-rose, or wild brier, and the red-leaved rose, all natives of Europe; the low or pasture rose of eastern North America; and the odd-looking Watson's rose, a native of Japan. Numerous herbaceous species of the rose family are grown at the herbaceous grounds.

Following this is the apple family; to this belong the apples and pears, many of which, being trees, may be found in the arboretum. Of a shrubby habit, and therefore members of this collection, are many of the hawthorns or thorn-apples, the quinces, the rose-boxes, the choke-berries, the service-berry and the shad-bush. Southward across the driveway from these, and overlooking the easterly lake, is the collection illustrating the plum family, to which belong the plums, cherries, apricots and peaches. As many of the species of this family are trees they may be found at the arboretum. Among those represented here are the western sand cherry, of northwestern North America; the three-lobed peach, a native of China, with its double-flowered form; the dwarf peach, from Europe; and the Russian almond, of Russia and western Asia.

Crossing the driveway to the west, the sequence is again taken up on the ground overlooking the west lake, with the senna family, represented by the Asiatic Judas-tree, of China and Japan, and the American Judas-tree of the eastern United States; in spring, before the appearance of the leaves, these are profusely covered with pink or purplish flowers. Across the transverse driveway to the north, and directly on the opposite side, may be found the pea family. Here are various species of the pea-tree: the pigmy pea-tree, from the Himalayan region; the Chamlagu pea-tree, from China; the common pea-tree and the small-leaved pea-tree, both from Siberia. In the fall the two-colored bush-clover, from China, is a show of purple bloom. The white broom, the common broom and the dense-flowered broom, all of Europe, have representatives here; of these, the common broom, in Spain and France attains the size of a small tree, and its wood is highly prized for veneering and cabinet work; its branches are extensively employed for making brooms, whence its common name. Other plants of interest are the false indigo and the bristly locust, both from the southeastern United States; the woody bladder-senna, from Europe and the Orient; and the scorpion senna, from southern Europe. Immediately beyond is the rue family, illustrated by the shrubby trefoil (*Ptelea trifoliata*) of the eastern United States; the prickly ash, from the northeastern United States; and the trifoliolate orange, from Japan, which has been used as one of the parents in the recent hybridization experiments by the U. S. Department of Agriculture in its effort to produce a more hardy orange; the lemon and forms of the orange may be found in the conservatories, together with other woody members of this family. The tanners'-tree family comes next with a single representative, the tanners'-tree, from the Mediterranean region. Following this is the box family, represented by a number of forms of the box-tree, from Europe, Asia and Japan; the wood of the box-tree is highly prized for wood-engraving, on account of its hardness and close fine grain, and it takes a fine polish. A few steps further on is the sumac family, to which belongs the common poison ivy, so frequent in and around New York City; here are the fragrant sumac, the mountain sumac and the smooth or scarlet sumac, all from the eastern United States; Osbeck's sumac is a stately shrub from China. The European and the American smoke-trees (*Cotinus*) are relatives of the sumacs; the former is sometimes called the wig-tree, on account of the flower-clusters which become white and feathery in fruit; a dye is obtained from it which is called young fustic.

Crossing the transverse path to the triangle, the holly family is on the nearest point, shown by the serrate holly and the crenate holly, both from Japan; the European holly is grown in the conservatories and the American holly at the arboretum. The Virginia winter-berry, of the eastern United States, bears its bright red berries far into the winter. On the opposite corner of the triangle is the staff-tree family, illustrated by many forms of *Euonymus;* the European staff-tree, the burning-bush of the eastern United States, the winged spindle-tree of eastern Asia and Bunge's spindle-tree of the Amur region are shown. Crossing the path to the north of the triangle we come to the maple family; most of the maples are trees, so they must be looked for in the arboretum, but here are specimens of the Ginnala maple, from northern China and Japan. Immediately beyond this is the bladder-nut family, represented by species of the bladder-nut (*Staphylea*), both from the New and the Old World. Following the path to the west, we come to the buckeye family, represented here by the small-flowered buckeye, from the southeastern United States; many of the buckeyes and horse-chestnuts are trees, and are grown in the arboretum. Following this is the soapberry family, with the genus *Canthoceras,* a native of China, as a representative. At some distance from the path to the left is the buckthorn family; the most familiar plant here is the New Jersey tea, or red root, of eastern North America; its leaves have been used as a substitute for tea, and it is said that the industry is being revived in Pennsylvania; the jujube-tree, an inhabitant of the Mediterranean region and temperate Asia, is of this family, its edible fruit oval in shape and about the size of a plum, with an acid taste when fresh; the Dahurian buckthorn, growing wild from central Asia to the Amur region, and the purging buckthorn of Europe, the berries of which are medicinal, are here; from the juice of the ripe fresh berries of the purging buckthorn, mixed with alum, is made the pigment, known as sap-green or bladder green, used by water-color artists. The mallow family, further along the path, is represented by two specimens of the rose-of-Sharon (*Hibiscus syriacus*), from western Asia, and often found escaped from cultivation in the eastern United States; many herbaceous representatives of this family may be found at the herbaceous grounds. Near the mallow family is the tea family, represented by the mountain *Stuartia,* from the southeastern United States; other members of the tea family, including the tea plant and the common camellia, may be found in the conservatories. Also near the mallows may be found the St. John's-wort shrubs (*Hypericum*), with their showy yellow flowers. Farther on, where the path bends to the left, is the tamarix family, represented by several species of tamarix, Old World plants. Next comes the mezereon family, having as a representative the leather-wood or moosewood (*Dirca*), of the eastern parts of North America; the name leather-wood refers to the very tough inner bark; the bark is a violent emetic.

Some distance from the path and opposite the Woodlawn Road entrance, is the oleaster family, including several species of oleaster, the buffalo berry and the sea-buckthorn, a native of Europe, the berries of which are acrid and poisonous; the berries of several of the species of oleaster are edible; the buffalo berry, of northwestern North America, is largely eaten by the Indians of that region; the berries of the oriental oleaster, known as Trebizond dates, are made into cakes by the Arabs, after having been dried. Plants of the ginseng family form a group opposite the same entrance, some of these being quite tropical in aspect; the Japanese angelica-tree, from Japan, is one of these, and another is Maximowicz's acanthopanax, also from Japan; the variegated Chinese angelica-tree, a native of China, is quite ornamental. Beyond this group, and on both sides of the transverse path, is the dogwood family, shown by many species of dogwood or cornel (*Cornus*), from both the Old World and the New; the red-osier dogwood, the kinnikinnik and the panicled dogwood are American representatives; the officinal dogwood comes from Japan and is known there as sandzaki; the dogberry, gater-tree, or hound's-tree, is from Europe and western Asia; its wood is hard and is sometimes made into butchers' skewers and tooth-picks; in France, an oil used for burning and in soap-making is extracted from the black berries.

Across the path from the dogwoods, at the foot of the steps, may be found the white-alder family. Here are the Japanese sweet-pepper bush and the North American sweet-pepper bushes or white-alders, their fragrant white flowers appearing in August. The heath family is next, represented by many forms of azeleas and rhododendrons; the Japanese

Pieris is a pretty plant, and another of the same genus, from the southeastern United States, is called stagger-bush. Following the path to the south, we come next to the huckleberries and to the shrubs of the storax family. On the other side of the path is the olive family, which covers a large area, extending along the path for a considerable distance; the olive-tree is the type of this family, and specimens may be found at the conservatories; in the fruticetum are several forms of the golden-bell (*Forsythia*), from China; a number of the privets, including the California privet, so much used for hedges; a variety of lilacs (*Syringa*), including the Rouen lilac, from China, the Pekin lilac, from southern China, the Himalayan lilac and the common lilac, a native of eastern Europe, so frequently cultivated in gardens, and the adelias. To the right of the path and following the storax family is the logania family, with species of *Buddleia,* including the showy variable buddleia, from China. Following this is the vervain family, and some of these shrubs are especially attractive in fruit, among them being the purple callicarpa, from China, and the Japanese callicarpa; most attractive is the late-flowering clerodendron, a Chinese plant, whose flowers have a delicious spicy fragrance, much like that of the sweet-pepper bush; the sepals are a beautiful rose color, while the corolla is creamy white; it blooms late in the summer or early fall, when flowers of shrubs are few.

We next come to the potato family, shown here by the matrimony vine, a native of Europe, but often found growing wild, its purple flowers followed by bright red berries; most of the hardy representatives of this family are herbs, so must be sought for in the herbaceous grounds, while many of the woody species, and some of the herbs, are tender, and may be found in the conservatories. The succeeding group is the honeysuckle family, to which is allotted a large area, there being many hardy kinds; the viburnums are represented by many species, both from the Old World and the New, such as the cranberry-tree, from north temperate regions, ornamental by its masses of bright red fruit; the dwarf cran-

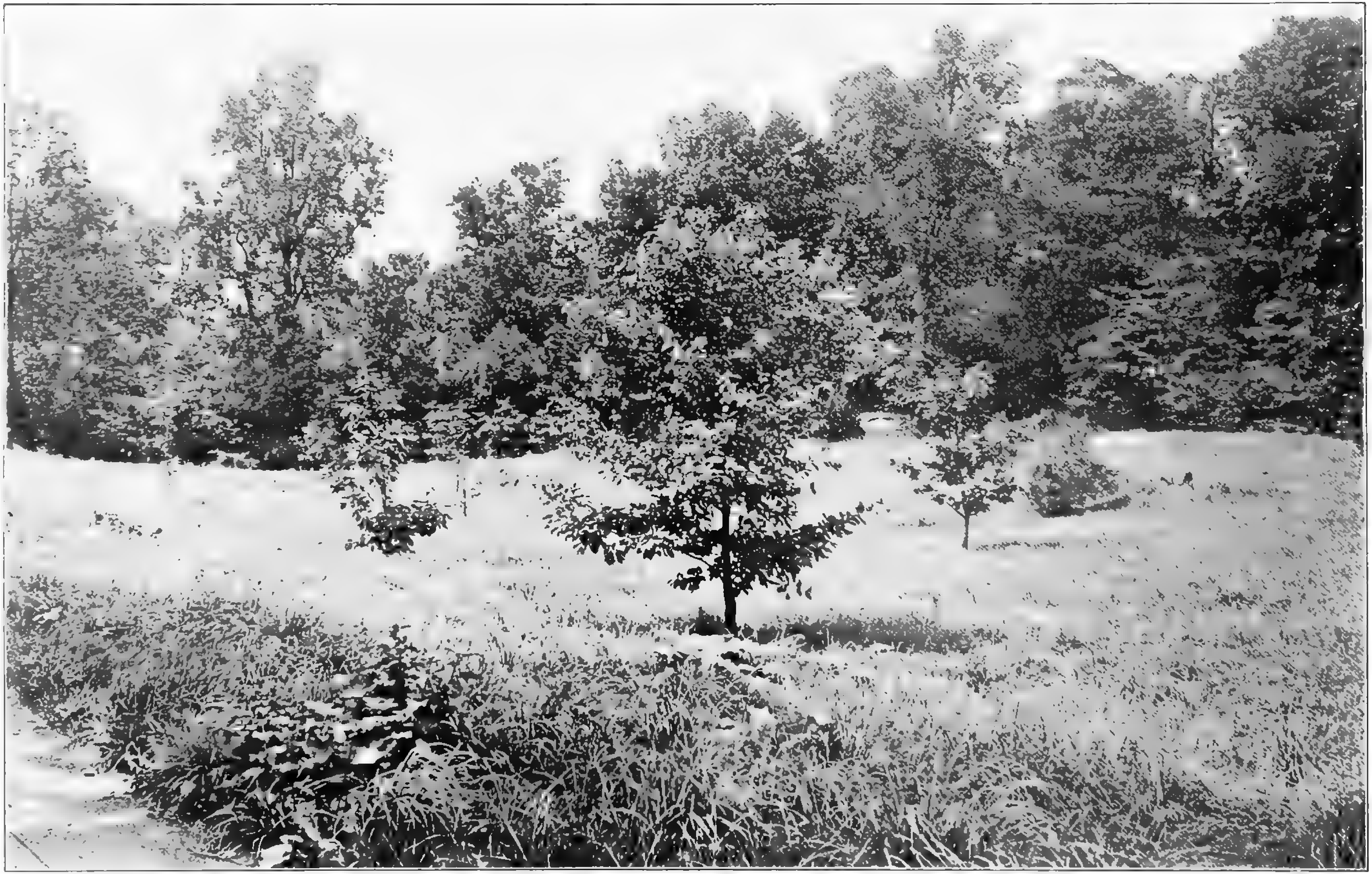
VIEW IN THE FRUTICETUM, OR SHRUB COLLECTION berry-tree, an exceedingly compact form, very dense in its growth; the Chinese viburnum, from China and Japan; Siebold's viburnum, from Japan; the Japanese snowball, from China and Japan; the wayfaring tree, from Europe and Asia; and the woolly viburnum, from China and Japan; among American forms may be mentioned the arrow-wood, the coast arrow-wood, the black haw or sloe, the withe-rod, and the larger withe-rod with its large bunches of showy fruit. The group of the honeysuckles occupies a position across the path from the viburnums, and here may be found, among others, the fragrant honeysuckle, from China, one of the first to send forth its blossoms richly laden with perfume; Morrow's honeysuckle, from Japan, covered with coral-red fruit in late summer and fall; Standish's honeysuckle, from China; the narrow-leaved Albert honeysuckle, from Turkestan; the blue fly-honeysuckle, from north temperate regions; and the golden-veined honeysuckle, from China and Japan, with the veins richly marked with yellow, or sometimes the whole leaf yellow. Across the transverse path to the south, and overlooking the lake, may be found the weigelas, symphoricarpos and the diervillas; the weigelas are illustrated by many showy forms, flowering in early summer; the showiest *Symphoricarpos* is the snowberry, native of northern North America, laden in autumn with its ivory-white fruit, making it most attractive; the diervillas are represented by two or three species, including the bush honeysuckle, a native of northern North America. The elder-berries (*Sambucus*) are also represented by two or three species. The Chinese abelia will also be found here; its fragrant flowers are borne in great profusion during late summer and early fall; the sepals are deep red-brown and the corolla is white, flushed with rose, making a pleasing combination.

Following the viburnums comes the thistle family. Few of the woody species of this family are hardy in this latitude, but large numbers of the herbaceous species may be found at the herbaceous grounds. As representatives in the fruticetum, we have the groundsel-bush or pencil-tree (*Baccharis*), a native of the southeastern United States, bearing in the fall a profusion of white fruit, making it a most attractive object; and some of the shrubby wormwoods (*Artemisia*) of the Old World.

Salicetum.—The area occupied by this plantation is between the main driveway and the Bronx River, north of the fruticetum, and comprises several acres. Here are brought together moisture-loving willows (*Salix*) and poplars (*Populus*) as a collection apart, many species grown here not being represented in the arboretum and fruticetum. Immediately beyond the uncompleted north path at the fruticetum is a row of poplars, fringing the southerly end of the north meadow, consisting of several trees each of Simon's poplar, from China, and Wobst's poplar, a Russian species. In the corner of the salicetum, next to the driveway, is a group of willows, consisting, in part, of the red-stemmed yellow willow, of horticultural origin, and the Ural purple willow. To the east of this may be found the golden, or yellow willow, of common occurrence in eastern North America, and Bashford's willow, a native of France. Along the west bank of the Bronx River may be found a row of trees of the cottonwood, or Carolina poplar, found wild in eastern North America; and another row of the weeping willow, a native of Asia. At the northern end of the area devoted to this plantation are to be found, among others, the purple willow, a native of Europe; and the black willow, of North America. Many other species are represented in this collection.

6. The Deciduous Arboretum

This plantation extends over most of the garden area east of the Bronx River. The sequence of plant families begins at the southeast entrance to the grounds and continues northward to the northern boundary, occupying the easterly ridge and the low grounds adjacent thereto. Here hardy trees are brought together, trees being regarded as woody plants which have a single main stem arising from the ground and not



VIEW IN THE ARBORETUM

branching until some distance above it. This collection is only partially formed, but additions are made to it every season. The groups will be referred to in the order of their sequence.

The first is the willow family which occupies the low-lying land near the southeast entrance and the ridge to the north, where a collection of willows and poplars may be found. Of these Simon's poplar, from China, is of rapid growth and upright habit, and more graceful than the cottonwood or Carolina poplar; the American aspen, a native of northern North America, the wood of which is largely manufactured into pulp for the making of paper; in northern British America it is the principal fuel of the Indians, as it burns freely when green and without sparks; the inner bark, which is sweet, is often used by them as a food in early spring. This tree has been of great service in re-foresting large tracts which have been denuded by fire; the long hairy appendages to the seeds enable the wind to carry them far and wide, and as they germinate quickly and the young seedlings grow rapidly in exposed situations, it is admirably adapted to the above purpose, quickly furnishing a covering for the land until more desirable trees may get a foothold. Bolle's poplar, a form of the white, or silver-leaf poplar, is quite ornamental in its lobed leaves; the white or silver-leaf poplar is a native of Europe and Asia. Another ornamental tree and one frequently used where quick growth is desired, is the eastern cottonwood, or Carolina poplar, common in eastern North America. There also is the Lombardy, or Italian poplar, from Europe and Asia, with its tall spire-like growth. Among the willows are the golden willow, from eastern North America, and the weeping willow, native of Asia, a tree commonly planted for ornamental purposes, and sometimes known as Napoleon's willow.

The walnuts and their relatives may be found to the west of the nursery on the ridge. The narrow-winged wing-nut, from China, and the Rhoeas-leaved wing-nut from Japan, are both here. Of the walnuts (*Juglans*), the English walnut, native from southeastern Europe to China, produces a most desirable nut, often called Madeira nut; the Romans introduced it into Italy, and from that place as a center its cultivation has spread in all directions, both in the Old World and the New; the nuts form a common article of food in southern Europe; in Europe and northern India an oil, called walnut-oil, used as a substitute for olive-oil, is obtained by subjecting the seed-leaves to pressure. The black walnut and the butternut are both wild elsewhere in the Garden. The pecan-nut (*Hicoria pecan*), wild in the south central United States, is another nut of popular favor, as is also the big shag-bark, or king-nut, of the eastern United States. The water hickory, of the southeastern United States, and the bitter-nut or swamp hickory, of eastern North America, are both represented, while the common shag-bark hickory and the pig-nut grow elsewhere in the grounds.

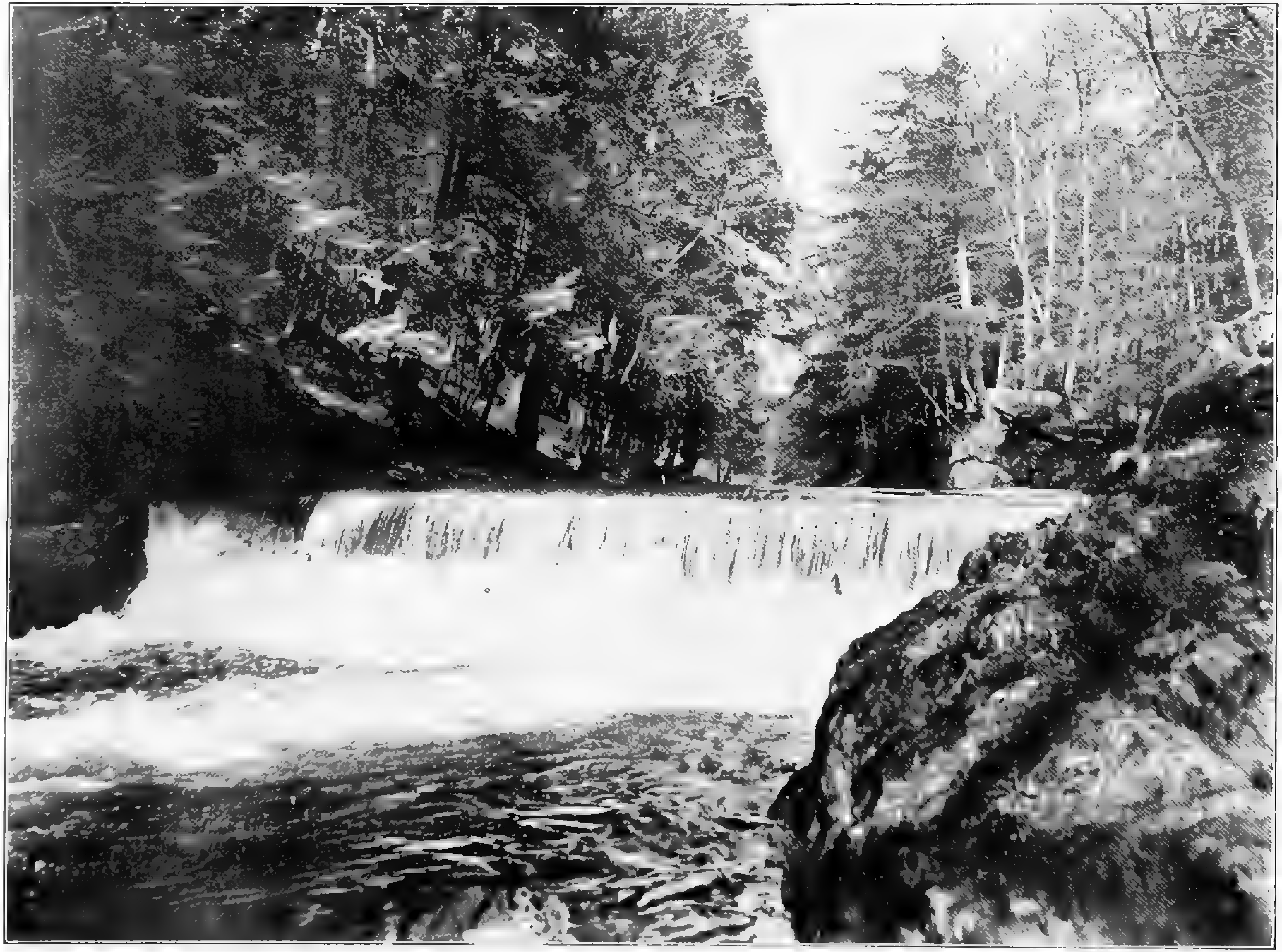
The birch family is located on both sides of the driveway to the south and southwest of the stable, where birches, alders and hornbeams are planted; the Japanese hornbeam is represented by a single specimen along the road to the propagating houses; the American hornbeam is common in Bronx Park, and the hop-hornbeam is occasional. Those desiring to study the birches (*Betula*) will find several species available; one of these is the yellow birch which grows wild in eastern North America, and is one of our most valuable timber trees; the wood, on account of its closeness of grain, strength and hardness, is suitable for many purposes. Another is the paper, or canoe, birch, of frequent occurrence in northern North America; the wood of this is preferred to that of any other tree for the manufacture of spools, and is also used in the manufacture of shoe-lasts and pegs; the Indians also make use of its wood in the manufacture of sledges, and from its tough bark they also make canoes and baskets. The Japanese white birch, a close relative of the American and European white birches, is represented. The river or red birch may be seen here; it is frequent along streams and lakes in the eastern parts of the United States; its wood is used in the manufacture of furniture. The black, or sweet birch, and the poplar-leaved birch are wild elsewhere in the Garden. The alders are present in several species: the dye alder, of Japan, which becomes a large tree; the Japanese alder, also of Japan; the speckled, or hoary, alder, of north temperate regions; and the European tree alder.

The area devoted to the beech family lies to the westward of that assigned to the walnut and birch families, and on both sides of the road leading to the Lorillard mansion. The oaks, the chestnuts and the beeches belong here. The oaks (*Quercus*) are represented by many species. One of those to the east of the road referred to above is the pinnatifid-leaved oak, from Japan, with its odd leaves cut into long linear lobes; it is said to be a form of the toothed oak of Japan. Near by is the rock chestnut oak, of eastern North America; its wood is strong and durable, especially when in contact with the soil, and is therefore of great value for railroad ties and fence posts, and its bark is largely used for tanning. The mossy-cup, or bur oak, also of eastern North America, may be found here; this was discovered by the botanist Michaux in 1795, and is a valuable timber tree, its wood largely used for boat-building, for the manufacture of carriages and agricultural implements, for the interior finish of houses, and, on account of its durability in contact with the soil, for railroad ties. To the west of the road may be found other oaks. The red oak and the swamp white oak are natives of eastern North America; the latter is also a good timber tree, its wood being used for cabinet work and in various kinds of construction. The Japanese silkworm oak forms a part of this collection; its leaves are much like those of the chestnut, and might easily be mistaken for them; it is often planted in Japan in the silk districts, as its leaves are available as food for the silkworms, whence its name; the Japanese make charcoal from its wood, and from the bark they extract a black dye. The post, or iron oak is a native of the eastern United States. Here may be seen also the sessile-flowered English oak, a native of Europe and western

Asia. The large-toothed oak, of Japan, a valued timber tree there, is represented near by; as is also the gland-bearing oak, another Japanese species. The shingle, or laurel oak, of the central parts of the United States, is not of much commercial value, as its wood checks badly in drying; it is sometimes used in making clapboards and shingles. Schneck's red oak comes from the south central parts of the United States. The Turkey oak, of southeastern Europe and western Asia, is valued in that region on account of its bark which is used in tanning leather. The swamp oak, the scarlet oak, the black oak and the white oak are to be seen in large wild specimens elsewhere in the grounds.

The chestnuts (*Castanea*) are represented by the Japanese chestnut, of China and Japan; in addition to this, in various parts of the grounds, the American chestnut may be found as wild specimens. The beeches (*Fagus*) are located to the westward of the chestnuts, in the north part of the swale. The European beech and its purple-leaved variety may both be found here in small, recently planted trees. Small trees of the American beech are also here, but large wild specimens may be found along the driveways and paths in the vicinity; the wood of the beech takes a high polish and is largely used for furniture, while the nuts are edible. The uses of the European beech are about the same as those of the American.

The elm family, to which belong the elms, the hackberries, or sugarberries and the water-elms, is located on the ridge to the north of the stable. Among the elms (*Ulmus*) to be found here is the Scotch, or Wych elm, a native of Europe and Siberia; the late-flowering elm, growing wild from Tennessee to Alabama; the cork, or rock elm, of northeastern North America; the Chinese elm, of northern China and Japan; and the winged elm, or wahoo, of the southeastern United States. The American elm and the slippery elm are wild in the grounds. The hackberries (*Celtis*) represented are the southern hackberry, of the southeastern United States; and the American nettle-tree, or sugar-berry, of eastern North America. The water-elms are illustrated by the pointed



WATER-FALL IN HEMLOCK GROVE

water-elm, a native of Japan. The mulberry family is represented by the osage orange (*Toxylon*), trees of which may be found to the south of the driveway; it is a native of the central parts of the United States; the red mulberry and the white mulberry are wild. The cercis-leaf family has for a representative the cercis-leaf, of Japan, located just to the south of the row of tulip trees just east of the Bronx River. The magnolia family is planted in the swale lying between the two ridges. Fraser's magnolia is one of those to be seen here; it is a native of the mountain woods from Virginia to Florida and Mississippi. The tulip-tree is shown by a row of fine wild specimens just to the south of the long bridge over the Bronx River, the largest trees within the grounds of the Garden. This tree is native of the eastern United States and yields a valuable lumber known as yellow poplar or whitewood; the Indians formerly made their canoes from this wood. The laurel family is represented by the sassafras, many trees of which may be found wild in various parts of the Garden. The sweet gum (*Liquidambar*), also wild in the grounds, represents the witch-hazel family.

The plane-trees are to be found just to the north of the elms. Here is a small tree of the oriental plane, native from southeastern Europe to India. A little to the southwest of this is a large specimen, native to the grounds, of the American plane, known also as the button-wood and button-ball, and there are many other wild trees along the Bronx River. The oriental plane is largely used as a shade tree in Europe and is sometimes planted in this country. The wood of the American plane, or button-wood, is largely used in the manufacture of boxes for tobacco, for furniture, and for the interior finishing of houses.

The apple family and the plum family are located to the north of the driveway leading to the long bridge. In the apple family may be found some of the tree hawthorns and thorns, including the Washington thorn, a native of the southeastern United States. Following to the west are some of the true apples (*Malus*), among them the Siberian crab-apple, a native of eastern Asia; the prune-leaved crab-apple, a native of northern China and Japan; and Soulard's crab-apple, from the central United States. In the plum family, among others, may be found the rose-bud cherry, a Japanese plant, and a highly decorative species; the double form of the Japanese flowering cherry, native throughout eastern Asia; the ordinary sweet cherry, originally from Europe and western Asia, a delicious fruit, of which there are many horticultural forms; and the ever-blooming cherry.

Near the eastern end of the long bridge are trees illustrating the senna family, located south of the bridge approach, and the pea family, the rue family and the mahogany family on the north side. One of those in the senna family is the honey-locust or three-horned acacia (*Gleditsia*), a native of the southeastern United States; its durability when in contact with the ground makes its wood of especial value for fence posts, for which purpose it is largely used; from China and Japan comes the Japanese locust, also represented here. Another of this family is the Kentucky coffee-tree, in several large and small specimens. One of the representatives of the pea family, from the Amur region, is the Amur yellow-wood (*Maackia*). Another is the locust-tree (*Robinia*), a native of the southeastern United States, but extensively naturalized elsewhere; its wood is hard and close-grained, and is very durable when in contact with ground or with water, so the high value in which it is held for fence posts and for ship-building may be readily understood. The rue family has for representatives the Japanese cork-tree (*Phellodendron*), from Japan, and the Chinese cork-tree, from the Amur region, China and Japan. The mahogany-tree family has a single species represented, the Chinese bastard-cedar, a native of China; the mahogany tree itself, and other representatives of the family, will be found at the conservatories.

On the ridge to the northeast of the apple family, and to the west of conservatory range No. 2, are trees of the ailanthus family, represented by the *Ailanthus,* or tree-of-heaven, a native of China, but extensively naturalized in the eastern

LAKE BRIDGE

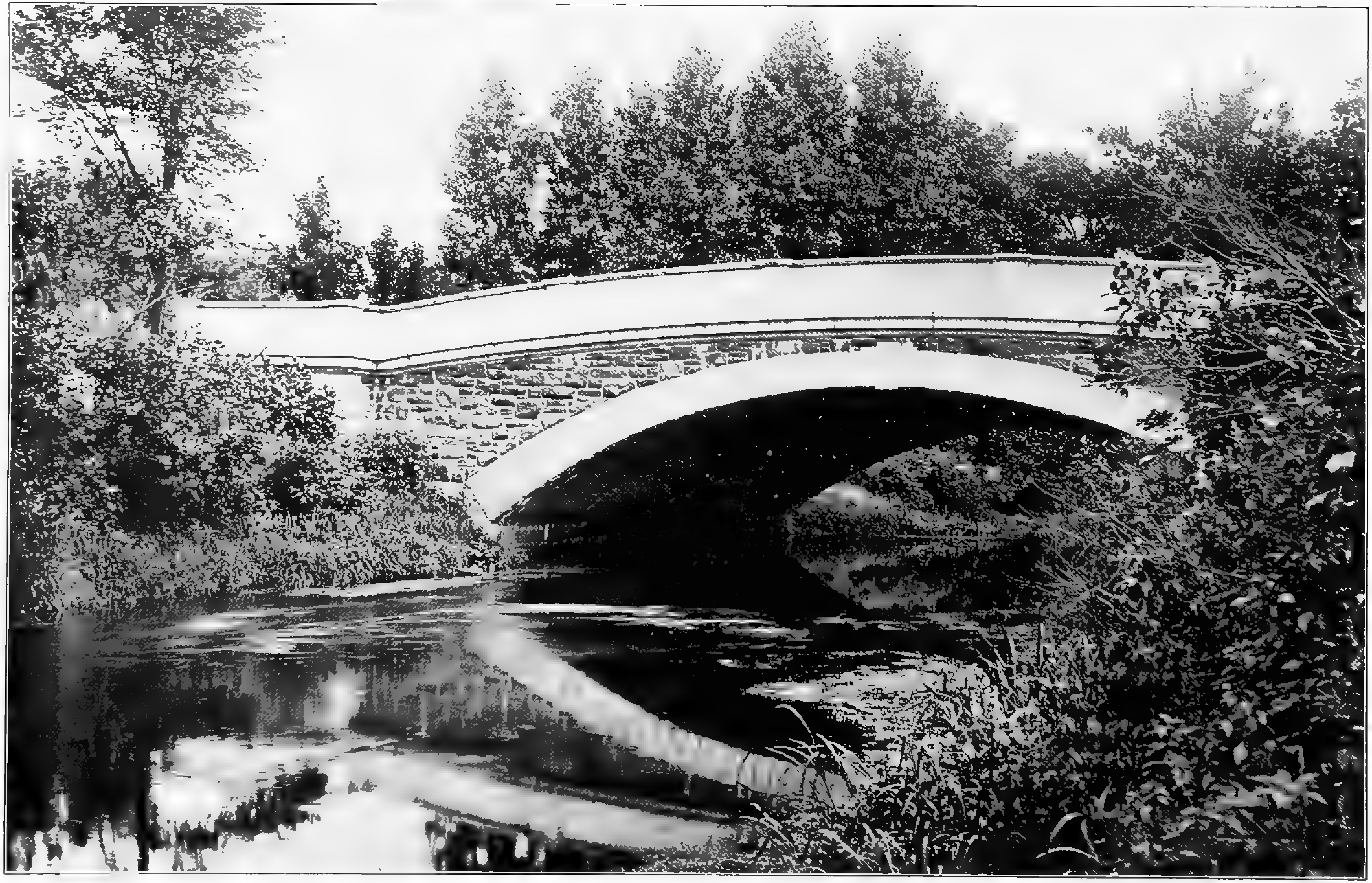
parts of the United States, where in some places it has become a nuisance, both on account of its ill-smelling staminate flowers and its habit of freely suckering from the roots.

On the ridge to the west of conservatory range No. 2 are the maple and buckeye families. The maples (*Acer*) are represented by a number of species. Perhaps the most important of these is the sugar, or rock maple, a native of eastern North America, and the principal tree yielding maple sugar and syrup. The sap is usually collected from late in February to early in April; trees from twenty to thirty years old are considered the most productive, and a tree will usually yield in a season from four to six pounds of sugar, some giving less and others much more. This tree is often planted for shade along streets and in parks, its beautiful coloring in the fall enhancing its value for this purpose. Its wood is largely used for making furniture, in ship-building, for tool-handles and for shoe-lasts and pegs. Another tree here is the red maple, ranging throughout eastern North America; its wood is now used in large quantities for the manufacture of furniture of various kinds, for gun-stocks, etc. The striped, or goose-foot maple, sometimes known also as moosewood, of northeastern North America, is a pretty decorative species, especially attractive on account of the beautiful marking of its bark. Two Old World representatives are the common European maple, of Europe and western Asia, and the sycamore maple, from Europe and the Orient. The sycamore maple is a valuable timber tree in Europe; its wood is used in the manufacture of musical instruments, spoons and other household utensils. From the southeastern United States comes the white-barked maple, also in the collection. The ash-leaved maple, or box elder, of eastern North America, is represented by several specimens.

In the buckeye family, planted near power house No. 2, is the common horse-chestnut (*Aesculus*) ; for a long time the native country of this tree was unknown, and its home was ascribed by different authors to various lands; it has been pretty well established now that it is indigenous to the mountains of Greece. Another tree here is the fetid, or Ohio buckeye, of the central United States; its wood, as well as that of some of the other kinds of buckeye, is manufactured into artificial limbs, for which purpose it is highly esteemed; it is also used for wooden-ware and paper pulp. To the north of the buckeye family is the linden family. The American linden, or basswood, found over the eastern parts of North America, is here; it produces a large amount of lumber under the name of whitewood, which is used in the manufacture of wooden-ware, furniture and carriage bodies; it is also largely used in the manufacture of paper pulp. Another species is the cordate linden, a native of Europe and Siberia, and a third is the white, or silver linden of eastern Europe.

Next in the sequence comes the ginseng family, represented by several species of aralia; many other species of this family may be found at the conservatories. West of these is the ebony family, represented by the persimmon or date-plum (*Diospyros*), a native of the southeastern United States; its wood is preferred for the manufacture of shuttles; its fruit contains tannin, which gives it its astringent properties; this fruit, when fully ripe, is eaten in large quantities in the southern states, and is also offered for sale in the markets of the north.

Beyond the ginseng family, on the western slope of the hill, is the olive family, represented by several species of the ashes (*Fraxinus*), some of which are useful for timber. The common European ash is to be seen, and among the North American representatives are the green ash; the Texas ash, restricted to that state; the Biltmore ash, from Pennsylvania to Georgia; the white ash and the red ash are common. Following to the north is the figwort family, represented by *Paulownia,* a native of Japan. Terminating the sequence is the trumpet-creeper family, represented by species of *Catalpa;* among these is the Indian bean, a native of woods in the Gulf States, and Kaempfer's catalpa, from China.



UPPER BRIDGE ACROSS THE BRONX RIVER

7. The Hemlock Forest

The forest of Canadian hemlock spruce along the Bronx River, within the portion of Bronx Park set apart for the New York Botanical Garden, is one of the most noteworthy natural features of the Borough of the Bronx, and has been characterized by a distinguished citizen as "the most precious natural possession of the city of New York."

This forest exists in the northern part of Bronx Park on the banks of the river and their contiguous hills; its greater area is on the western side of the stream, but it occupies a considerable space on the eastern side above the Lorillard mansion and below the boulder bridge. The area west of the river extends from just above this bridge down stream to a point nearly opposite the old Lorillard snuff mill, and is the part commonly designated "Hemlock Grove." Its total length along the river is approximately 3,000 feet; its greatest width, 900 feet, is at a point on the river about 700 feet above the water fall at the Lorillard mansion. The total area occupied by the trees on both sides of the river is between thirty-five and forty acres.

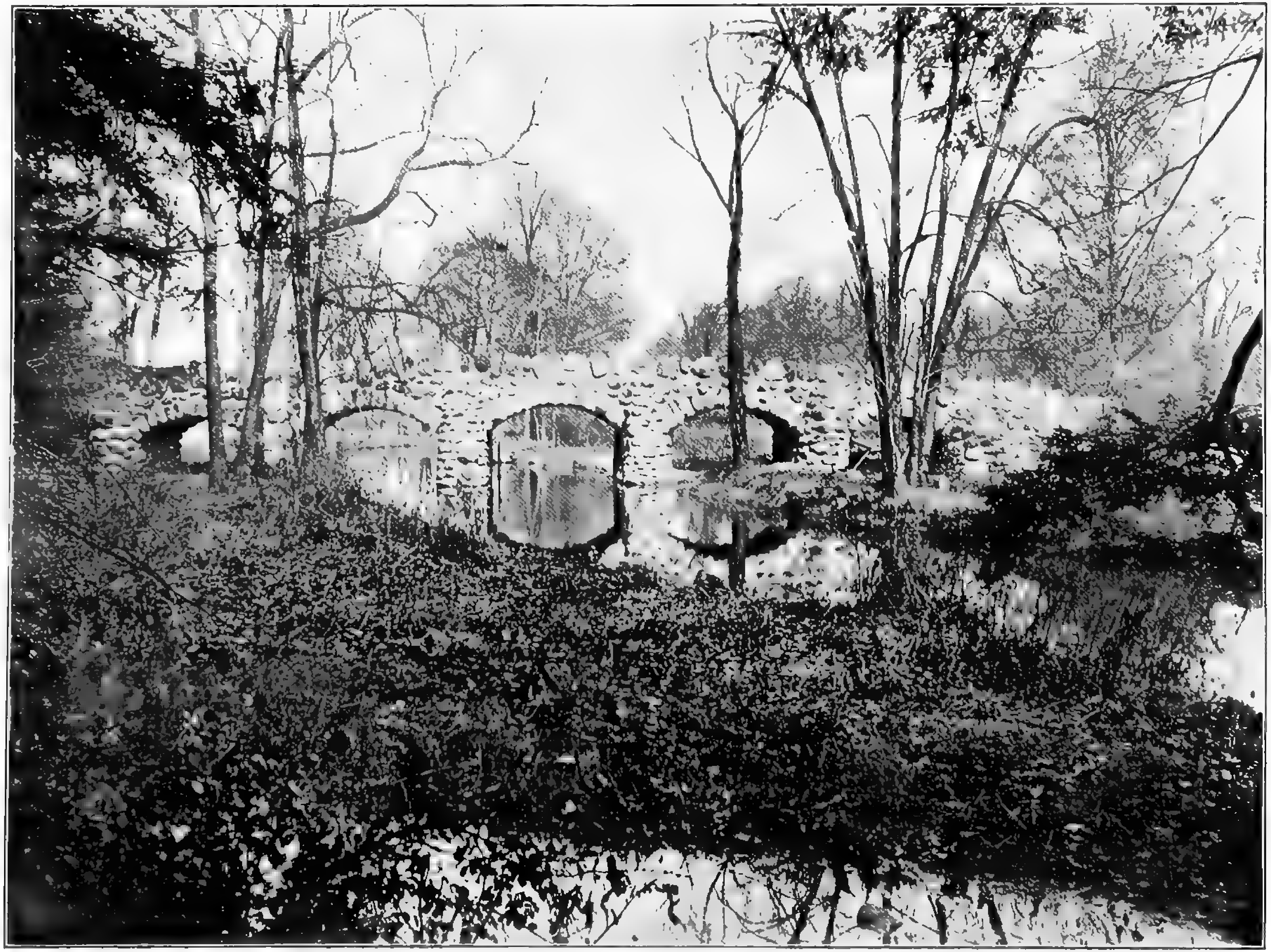
While this area is mostly covered by the hemlock spruces, and although they form its predominant vegetation, other trees are by no means lacking; beech, chestnut, sweet birch, red maple, hickory, oaks, dogwood, tulip-tree and other trees occur, and their foliage protects the hemlocks from the sun in summer to a very considerable extent; there are no coniferous trees other than the hemlock, however, within the forest proper. The shade is too dense for the existence of much low vegetation, and this is also unable to grow at all vigorously in the soil formed largely of the decaying resinous hemlock leaves; it is only in open places left by the occasional uprooting of a tree or trees by gales that we see any considerable number of shrubs or herbaceous plants, their seeds brought into the forest by wind or by birds. In fact, the floor of the forest is characteristically devoid of vegetation, a feature shown by other forests of hemlock situated further north. The contrast in passing from the hemlock woods to the contiguous hardwood area which borders them to the west and north, toward the museum building and the herbaceous grounds, is at once apparent, for here we see a luxuriant growth of shrubs and of herbs, including many of our most interesting wild flowers.

8. The Gorge of the Bronx River

The gorge of the Bronx River extends from the boulder bridge at the north end of the Hemlock Forest southward for about a mile, nearly to Pelham Avenue, and is a most beautiful and picturesque natural feature, besides being of great geological significance. Its depth from the summits of the hills on both sides averages nearly 75 feet, and its sides below the foot-bridge at the Lorillard mansion are nearly vertical rock faces. The hills on both sides are heavily wooded with hemlock spruces and other trees. In the upper part of the gorge the Bronx flows slowly, being held back by the dam forming the water-fall at the Lorillard mansion, and the elevation of its surface is only a few inches higher at the boulder bridge than it is at the fall; after plunging over the dam, however, the river runs in its unobstructed natural channel with all the appearance of a mountain stream, which at high water is exceedingly beautiful.

9. North Meadows and River Woods

The Bronx River enters the northern end of the Garden from Williamsbridge and flows as a slow stream southward to the water-fall at the Lorillard mansion, its surface being nearly level throughout this distance. It is spanned just inside the northern boundary of the Garden by a concrete-steel arched bridge with granite copings, which carries the main park driveway across it near the Newell Avenue entrance. The entire northern end of the Garden is formed of the flood plain of the Bronx River, consisting largely of grassy meadows and marshes which at average flow of the stream are several feet above its surface, but which at flood time are occasionally submerged for short periods, the whole



BOULDER BRIDGE

valley being a very interesting illustration of the behavior of a small stream with a large water-shed at and about its sources. Considerable areas of the marshy land have already been reclaimed by filling, and by the lowering of the dam forming the water-fall at the Lorillard mansion; the general plan contemplates a much further reduction in the amount of marshy ground, and a further lowering and deepening of the river by dredging, in order to take off freshets with greater rapidity. A part of this flood plain is occupied by the plantations of willows and poplars already described, and these will be considerably extended, but large areas of meadow will be left in their natural condition.

South of these open meadows, the valley of the river is much narrower and is occupied by several acres of characteristic river woods, containing a considerable variety of native trees and shrubs, extending south as far as the long driveway bridge near the northern end of the hemlock forest.

Park Features

The whole plan of the development of the Garden has been designed in such a manner as to include all the features of a public park, and it has been carried out in close coöperation with successive park commissioners and engineers of the Borough of the Bronx. The grounds are open to the public every day in the year without any charge whatever. An elaborate series of driveways provides several miles of Telford-Macadam roads, most of which are now constructed, with suitable entrances at eight points as follows:

1. Mosholu Parkway. 2. Bedford Park Avenue. 3. Southern Boulevard. 4. Hemlock Forest. 5. Southeastern entrance (not yet constructed). 6. Bleecker Street. 7. Newell Avenue. 8. Woodlawn Road.

Paths located so as to lead to all the principal features are included in the plan, with an aggregate length of over ten miles and approximately one-half of this system has already been built.

All the roads and paths have been located so as to do no damage to the natural features of the grounds, particular care having been taken to save all possible standing trees and to avoid disturbing natural slopes except in the immediate neighborhood of the large buildings, where considerable grading has been necessary, but even here the study has been to adjust the new surfaces so that they shall merge imperceptibly into the original ones. Ornamental masonry retaining walls, made necessary by the grades of the roadways, have been built at the Mosholu Parkway entrance, at the Woodlawn road entrance, and at the approach to the Elevated Railway station, and vines have been planted at the bases of these walls which partly clothe them with foliage.

The plan of the driveway and path systems called for the construction of six bridges; three of these, first, the lake bridge, crossing the valley of the lakes near the museum building; second, the long bridge, which carries the driveway across the valley of the Bronx River north of the hemlock forest; and, third, the upper bridge which crosses the Bronx River at the northern end of the Garden, have been carried out in masonry arches from designs by Mr. John R. Brinley, landscape engineer of the Garden. A stone boulder foot-bridge of five arches, just at the northern end of the hemlock forest was built from designs by the same engineer; studies have been made for a bridge to replace the wooden bridge which crosses the gorge of the Bronx River at the Lorillard mansion; and the sixth bridge in the plan is a foot-bridge, not yet built, to cross the Bronx River in the north meadows.

The park treatment further contemplates the planting of shade trees where these are needed along the driveways, and much of this has been done, a great many kinds of trees having been used, and many shrub plantations have been set out, especially at roadway and path intersections, utilizing considerable numbers of the same kinds of shrubs at different points.

A PART OF THE BORDER SCREEN

The drainage of the grounds has been carried out in accordance with a well-studied original plan, which provides outlets for the surface drainage for the most part either into the lakes or into the river, only a small portion of it being taken into the sewers; a considerable portion of the drainage system still remains to be built.

The water supply has also been constructed in accordance with the general plan and the system is being extended from year to year as the development of the grounds proceeds.

The general planting plan includes provision for completely surrounding the grounds, except at entrances, with border screens. This planting has already been accomplished along the entire western and northern boundaries, and partly along the southern boundary. These screens are composed of a very great variety of trees and shrubs, variously grouped, and average about fifty feet in width. It has not been practicable hitherto to plant these screens along the eastern border of the park on account of being obliged to wait for the construction of the street known as the Bronx Boulevard or Bronx Park East, the land for which has recently been secured by the city by condemnation proceedings.

A feature of this border screen is an old-fashioned flower border, composed of herbaceous plants in large variety, which extends from the 200th Street, or Bedford Park Avenue, entrance northward to the New York Central Railroad Station and thence to the Mosholu Parkway entrance, and there is a similar plantation at the Elevated Railroad station; here herbaceous perennials are massed in front of a belt of flowering shrubs which in turn are backed by the trees of the border screen, and so selected that some of them are in bloom throughout the season. Among the plants used in this old-fashioned flower border are daffodils, crocuses, irises, phloxes, paeonies, rose mallows, sun-flowers, cone-flowers, coreopsis, columbines and many others.

Guides

In order to provide a method for viewing the collections under guidance, an aid leaves the front door of the Museum Building every week-day afternoon at 3 o'clock, to escort all who may wish to accompany him. The routes are as follows:

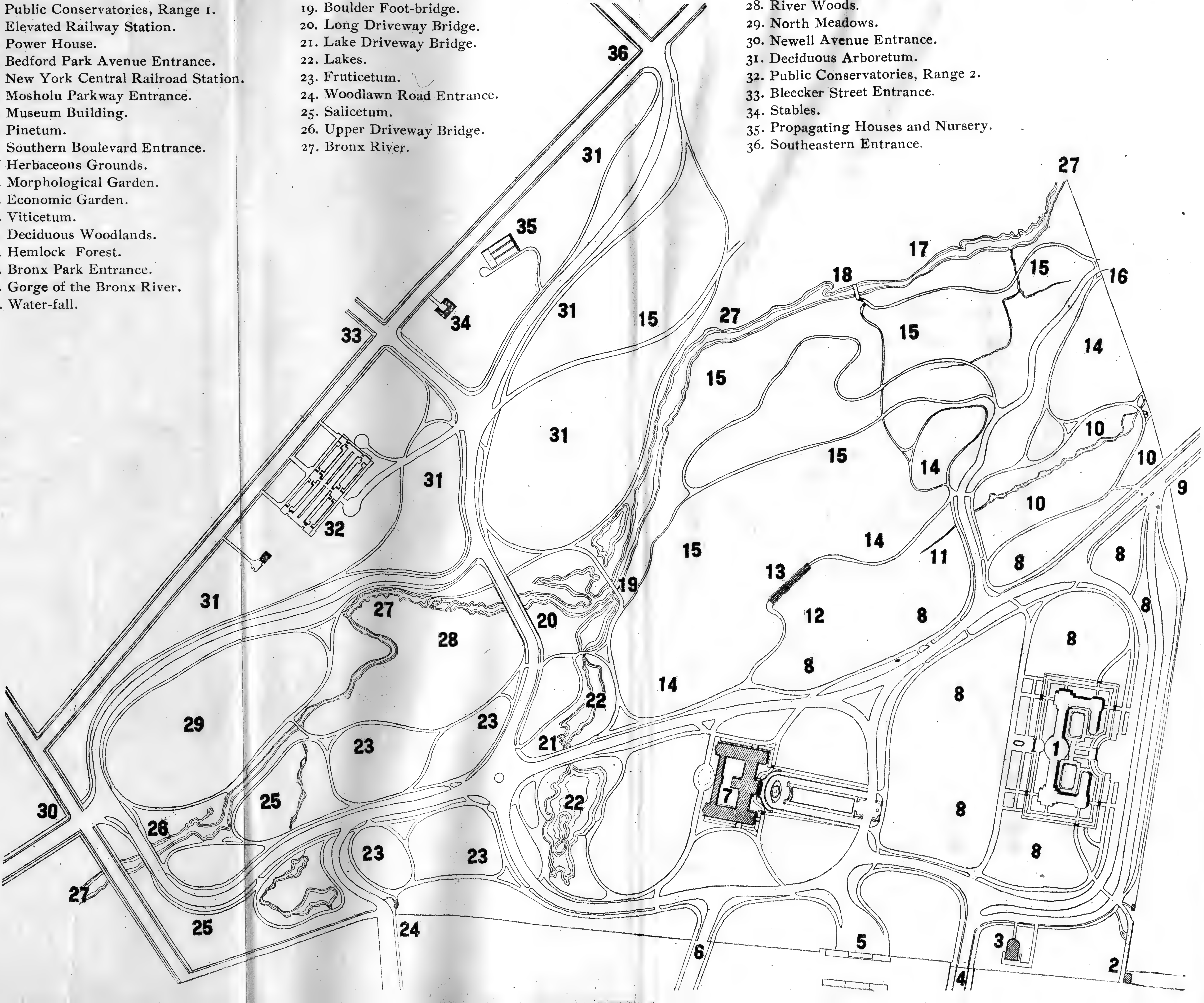
Monday: Hemlock Forest and Herbaceous Garden. Tuesday: Pinetum. Wednesday: Fruticetum and North Meadows. Thursday: Deciduous Arboretum, Nurseries, Propagating Houses. Friday: Public Conservatories. Saturday: Museums.

City Ordinances

1. The picking of flowers, leaves, fruits, nuts, or the breaking of branches of any plants, either wild or cultivated, the uprooting of plants of any kind, the defacing of trees, and the carrying of flowers, fruits or plants into or from the grounds of the Garden, are prohibited, except by written permission of the Director-in-Chief of the Garden.
2. Leaving or depositing paper, boxes, glass or rubbish of any kind within the grounds of the Garden is forbidden.
3. Dogs are not allowed within the limits of the Garden except in leash.
4. It is forbidden to take fish from within the Garden, or to molest in any way squirrels, birds, snakes, frogs, toads, turtles or any other wild animals.
5. Throwing stones or other missiles, playing ball, football, tennis, or other game is prohibited.
6. It is forbidden to offer for sale food, candy, newspapers, books, tobacco, beverages, flowers or any other objects, without written permission from the Director-in-Chief and the Commissioner of Parks for the Borough of the Bronx.
7. Boating or rafting on the ponds, lakes and streams is forbidden.
8. Trucking, or the driving of business wagons of any kind, is forbidden on the roads of the Garden, except on those designated for such purposes.

GENERAL PLAN OF THE YORK BOTANICAL GARDEN

1. Public Conservatories, Range 1.
2. Elevated Railway Station.
3. Power House.
4. Bedford Park Avenue Entrance.
5. New York Central Railroad Station.
6. Mosholu Parkway Entrance.
7. Museum Building.
8. Pinetum.
9. Southern Boulevard Entrance.
10. Herbaceons Grounds.
11. Morphological Garden.
12. Economic Garden.
13. Viticetum.
14. Deciduous Woodlands.
15. Hemlock Forest.
16. Bronx Park Entrance.
17. Gorge of the Bronx River.
18. Water-fall.
19. Boulder Foot-bridge.
20. Long Driveway Bridge.
21. Lake Driveway Bridge.
22. Lakes.
23. Fruticetum.
24. Woodlawn Road Entrance.
25. Salicetum.
26. Upper Driveway Bridge.
27. Bronx River.
28. River Woods.
29. North Meadows.
30. Newell Avenue Entrance.
31. Deciduous Arboretum.
32. Public Conservatories, Range 2.
33. Bleecker Street Entrance.
34. Stables.
35. Propagating Houses and Nursery.
36. Southeastern Entrance.



9. It is forbidden to accept or solicit passengers for any cab, carriage, or other conveyance, at any point within the grounds of the Garden without written permission from the Director-in-Chief of the Garden and the Commissioner of Parks for the Borough of the Bronx.

10. Visitors are not allowed within the Garden after eleven o'clock at night nor before six o'clock in the morning, except upon driveways and paths designated for their use between those hours.

APPENDIX

NATIVE TREES OF THE HUDSON RIVER VALLEY*

By Norman Taylor

The valley of the Hudson River contains most of the trees native in the northeastern United States. It is probable that all species which grew there at the time of Henry Hudson's visit in 1609, grow there today, although, owing to the clearing of land for agricultural purposes, and to the cutting of forests for wood, the number of individuals of most kinds has been much reduced.

In the following account, the trees known to grow naturally in the counties of New York and New Jersey which border the Hudson River have been included. A few of the species may not occur immediately within the topographical area of the valley itself but all the others might have been seen by the explorers.

White Pine PINUS STROBUS

The white pine, one of the most beautiful and the best known of our native evergreens, is a tall tree reaching a maximum height of 200 feet in some parts of the country; but in the Hudson Valley it is never so tall as this. The trunk is continuous, but in some rare cases it forks. The bark is fissured on the old trunks, but smoother and greenish-red on the young ones. The system of branching is very characteristic and exceedingly graceful. The upper branches are somewhat erect, but the middle and lower ones stand out

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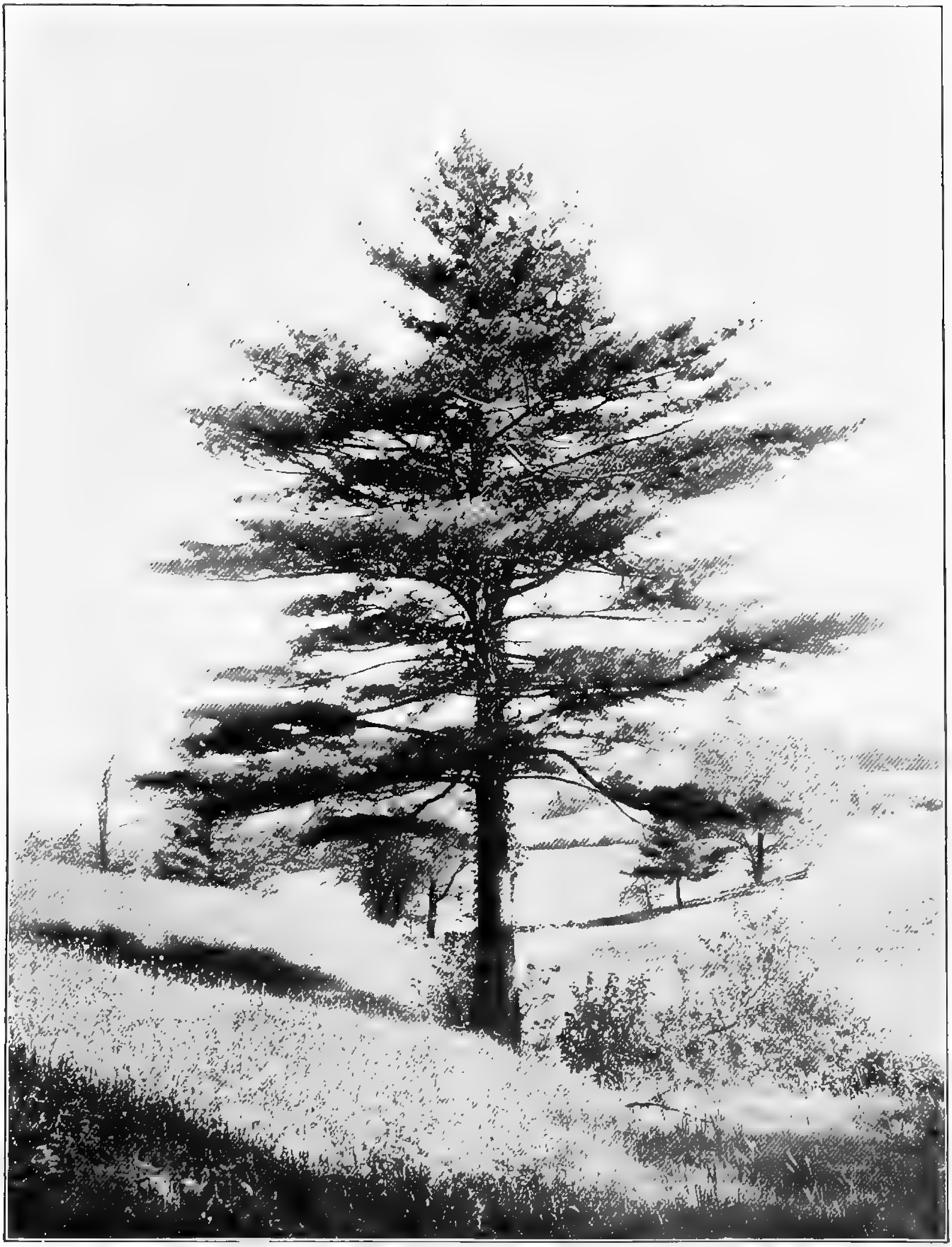
* This descriptive list of trees growing naturally near the Hudson River has been prepared at the request of the Hudson-Fulton Celebration Commission. N. L. B.



WHITE PINE

New Baltimore, Greene County, N. Y.

straight from the trunk, or even droop a little at their tips when old. As in all pines the leaves are very slender and sharp-pointed, whence the name "pine-needles." Unlike all the other Hudson Valley pines this species has five of these needles in a cluster; there is a little tubular sheath enclosing the bases of the leaves when young. In the white pine the leaves are from 3 to 5 inches long and pale green or bluish-green in color.

The flowers, which appear in May or June, and the subsequent seeds, are found at the bases of scales, the pistillate of which collectively form the well known "pine-cone." During the second year the scales of the cone loosen and release the winged seeds.

The white pine prefers sandy slopes and is found in all the counties bordering the Hudson Valley; rare and local on Staten Island, but abundant northward. Its timber is very valuable and few forests of it remain uncut. (Plate 131.)

Pitch Pine PINUS RIGIDA

The pitch pine, a round-topped but often irregularly shaped evergreen, attains a height of 50 or 60 feet. The bark is coarse, irregularly and deeply fissured when old, and red-brown in color. The branches are stiff and stand out straight from the trunk, in age becoming twisted and irregular.

The bright green leaves are arranged in clusters of three, enclosed at the base by a sheath, and persistent for 2 or 3 years. They are stout, sharply but closely toothed and from 2½ to 5 inches long.

The flowers come out in spring, the pistillate or "cones" being almost without stalks and arranged in clusters along the sides of the branches. They are scarcely more than 2½ inches long and globose or ovoid in outline. The scales of the cone, which are armed with strongly recurved prickles, spread to release the seed during the second season.

The wood of the pitch pine is used for a variety of purposes where coarse lumber is needed. As a source of turpentine it has been superceded by the southern long-leaved pine. We find it growing freely throughout the lower part of the Hudson Valley, and it forms most of the "pine-barrens" of Long Island and New Jersey. (Plate 132.)

Short-leaved Pine PINUS ECHINATA

On Staten Island and in adjacent New Jersey the short-leaved pine reaches its most northerly known stations. The trunk is tall and somewhat tapering, and usually bears numerous branches that are slender and droop at the tip. The old bark is roughly fissured and usually reddish in color.

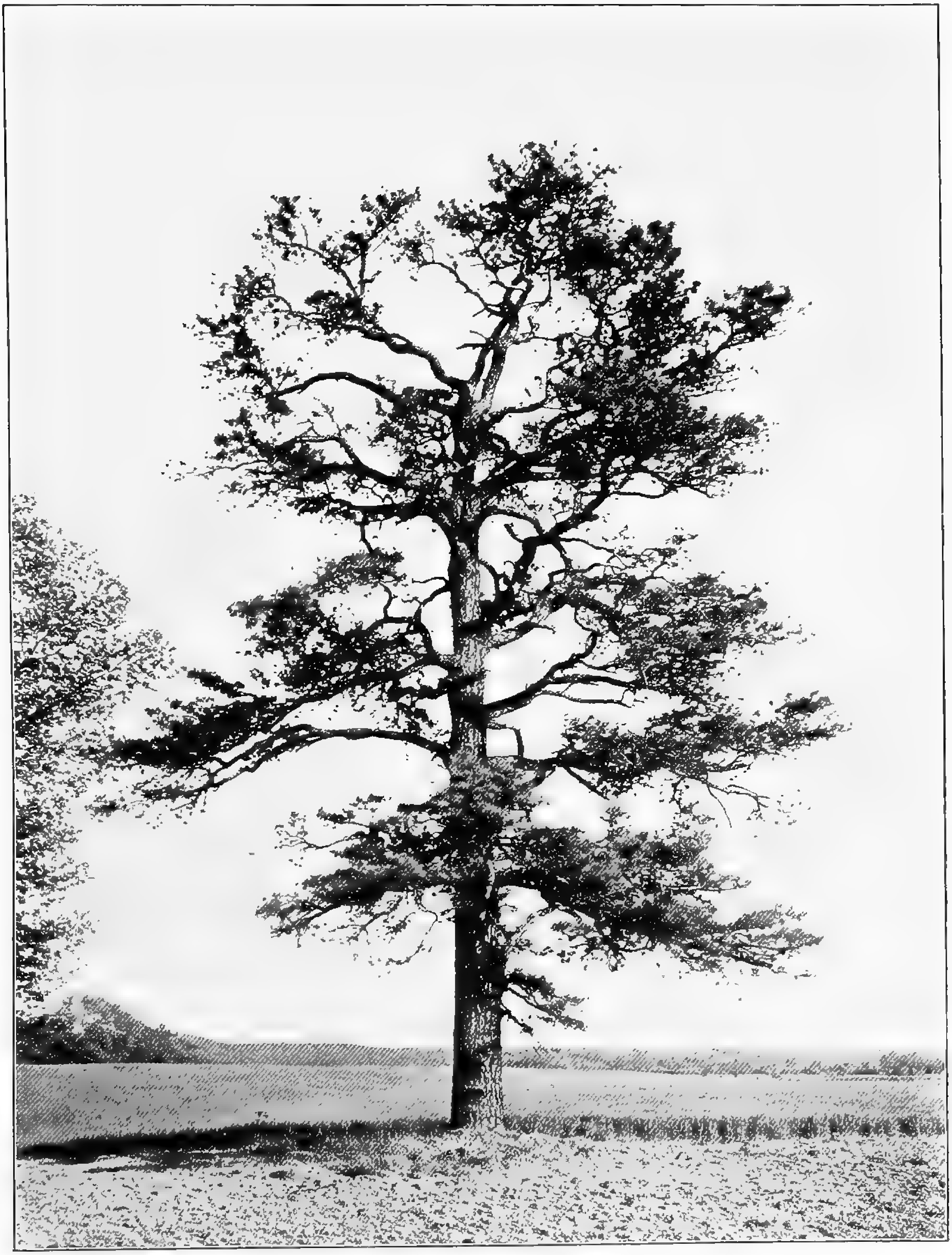
The leaves of the short-leaved pine are mostly in clusters of twos or threes. The bases of the leaves are enclosed by a tubular sheath which stays on as long as the leaf still clings to the branch; in this pine the leaves often persist for three or even five years. The "needles" are from 2 to 5 inches long and sharp-pointed, their margins are closely and finely toothed, thus feeling rough to the touch.

The flowers come out in April or May and the pistillate or "pine-cone" are almost always found at the sides of the branches on short stalks. Occasionally they may grow on the ends of the branches. Two or three, sometimes four, grow together, and after they spread their scales, which are prickle-tipped, they often hang on the branches for several years.

In North Carolina this evergreen is often tapped for turpentine, and it is used very generally for woodworking. It grows in sandy or clayey situations from Texas to Florida and northward to southern New York.

Scrub Pine PINUS VIRGINIANA

In the lower Hudson Valley the scrub or Jersey pine as it is sometimes called is scarcely more than 40 feet tall, but in the west it is often 100 feet in height and 3 feet in diameter. The bark is reddish-brown and splits into large plates. The branches, several of which arise as successive whorls on the trunk, are slender and often drooping at their tips.



PITCH PINE

New Baltimore, Greene County, N. Y.

The leaves of the scrub pine are twisted and this character serves to distinguish it from all the other pines of the Hudson Valley. The "needles" are from an inch and a half to two and a half inches long and arranged two in a cluster, their bases being enclosed in a persistent sheath.

The cones are without a stalk and usually attached to the side of a branch but sometimes at the end of it. When closed they are conical in outline, but become ovoid when the scales loosen to release the seers. The scales are prickle-tipped.

Commercially the tree is of little importance, the wood being soft and weak. It has little decorative value, except in picturesque masses, as it is more or less scraggy. It is much valued as a reforester, for it quickly covers burned or worn out areas. It reaches its northernmost limit on Staten Island and adjacent New Jersey.

Red Pine PINUS RESINOSA

In favorable situations the red pine often attains a height of 120 feet, and a trunk diameter of 3 to 4 feet. The tall straight trunk is clothed with scaly reddish bark that is only shallowly fissured.

The sharp-pointed "needles" are arranged in clusters of two, and their margins are minutely toothed. They are from 5 to 7 inches long, slender and flexible. The infertile flowers bloom in May, followed later by the fertile flowers and "cones." The latter are oblong in shape, from 2½ to 3½ inches long, and composed of numerous scales that are turned backward at their tips, but are without prickles. These blunt-tipped scales of the cone distinguish this tree from all the other pines of the valley, except the white pine, from which the red pine differs in having only two leaves to a sheath instead of five.

The red pine is occasional in the upper Hudson Valley, and a record exists of its having once grown at Inwood on Manhattan Island. It is distributed from Nova Scotia to Minnesota and southward to the mountains of Pennsylvania.

American Larch LARIX LARICINA

The tamarack or larch is the only Hudson Valley conifer which loses all its leaves during a single season. It is a round-topped tree when young, but in age the branches often become contorted and consequently the whole tree is scraggy in appearance. The leaves are narrow, triangular in section, and bright green in color, becoming yellow before they fall in the autumn. They are usually not more than 1½ inches long and arranged in isolated little clusters. The flowers come out in spring and the pistillate or cones are scarcely more than three quarters of an inch long. They mature during the first season.

The larch usually grows in cold bogs where it may form dense forests. It reaches its southerly limit in Pennsylvania and West Virginia. The wood is much used for railway ties, ship construction and for telegraph poles.

Swamp Spruce PICEA MARIANA

Within the Hudson Valley region the spruce, with the larch, seems to be confined to low bogs. Far north the tree grows on slopes and attains a height of 100 feet, it is never so tall as this in our area. The bark is thin, closely fissured and brownish in color. As in all the spruces the leaves are four-sided; in this sort they are not more than a half inch long, sharp-pointed, and bluish-green in color. They are usually scattered on the hairy twigs. The pistillate flowers or cones are fastened to a strongly incurved stalk. They are oval in outline and composed of numerous small scales which are notched at the top. The tree may often be seen with cones several years old still clinging to the branches.

The wood of the swamp spruce is soft and is occasionally used as lumber, but it is now an important source of paper pulp. It grows practically throughout the northeastern part of the continent, coming down as far south as Pennsylvania and West Virginia.

The red spruce (*Picea rubens*) also growing in the Hudson Valley may be distinguished from the swamp spruce by its lustrous green leaves, by its early falling cones, and by the scales of the cones, which are scarcely ever notched. The red spruce is also used in making paper pulp and its sap furnishes the commercial spruce gum. It grows in a narrow belt from New Brunswick to Tennessee. Both these spruce trees are essentially northern plants, and in the Hudson Valley are more common near the mountains than southward.

Hemlock Spruce TSUGA CANADENSIS

The hemlock, one of our slow-growing evergreens, reaches its greatest development in the northern part of the continent. It frequently forms exclusive forests under favorable conditions, but southward the trees become scattered and intermingled with other kinds. One of the most southerly groves is that within the grounds of the Botanical Garden where the tree has practically exclusive control of a tract of some 35 acres. It is common along the Palisades.

The tree is sometimes as high as 120 feet, with a stout trunk covered with a coarse roughly ridged bark. The branches stand out straight from the trunk when old or droop slightly at their tips. The arrangement of the twigs and leaves in a practically flat plane with the branch gives the tree a very characteristic and beautiful facies. Unlike the spruce the leaves of this hemlock are flat; they are bluish green on the under side and dark olive green on the upper. They are seldom more than ⅔ inch long and rounded at the tip.

The cones mature the first season and shed their seeds during the winter; they are smaller than the cones of the pines, scarcely ever being more than ¾ inch long. They are usually found attached by a short stalk to the tips of the young branches.

The rough coarse lumber of the hemlock is used only for general construction purposes, and the tree is of economic importance almost solely on account of its bark which is an important agent in tanning leather.

Balsam Fir ABIES BALSAMEA

The balsam fir occurs but sparingly in the lower Hudson Valley, it being chiefly a northern tree and abundant in the Adirondacks. It forms, when isolated, a broad, symmetrical tree of cone-like shape scarcely exceeding 75 ft. in height. The trunk is covered with a smooth gray bark which has numerous resinous blisters spread throughout it. The resin exuded is the well-known Canada balsam of commerce. The branches are arranged in successive and sometimes widely separated whorls; in age they droop slightly at their ends. There are usually two kinds of leaves on the balsam fir, those on the cone-bearing branches and those found only on branches not cone-bearing. On the former they are about ½ inch long and sharp-pointed, but on the sterile branches they are twice as long and usually rounded at the tip.

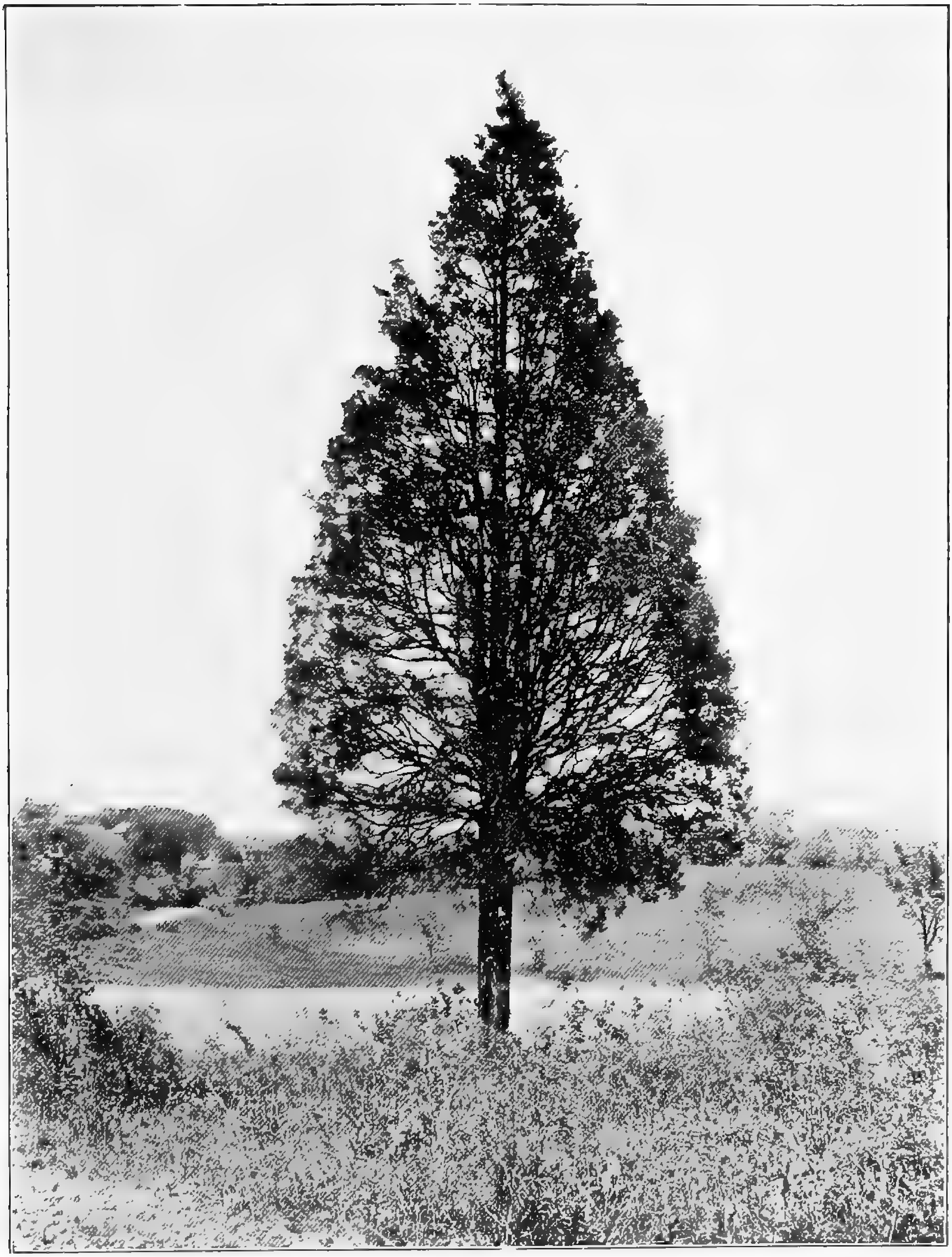
The cones, which stand erect on the branches, instead of drooping as they do in most of our evergreens, are from 2 to 4 inches long and composed of numerous roundish scales. The tree may often be found with only the naked stalk of the cone clinging to the branch; as the scales fall off, from the top downwards, thus releasing the seeds, while the stalk is still fast to the branch.

This evergreen, which in the Hudson Valley region prefers moist situations, has been lately used in making paper, but for general purposes its wood is too soft and coarse-grained.

Red Cedar JUNIPERUS VIRGINIANA

Because of its use in making moth-proof chests, and in the manufacture of lead-pencils, the red cedar or juniper, is one of the trees that comes more closely in touch with every-day affairs than almost any other Hudson Valley evergreen. It is common throughout the area in soil that will maintain scarcely any other trees, loves rocky and exposed places and will stand any amount of abuse from the elements.

The tree is tall, straight, and spire-like, with the lower branches somewhat spreading and the upper always erect. The trunk, which is covered with shedding, fibrous bark, is



RED CEDAR

New Baltimore, Greene County, N. Y.

fluted and often buttressed at the base. It has two kinds of leaves; those on the vigorous young shoots are awl-shaped, about ¾ in. long, and spreading from the twig. On the old branches the leaves are reduced to tiny scales which are pressed flat against the branches.

The flowers come out in early spring; those which subsequently form the fruits are never found on the same tree as the none-fruiting flowers. The fruits, which are cones, become pressed into a bluish berry-like structure, are ¼ inch in diameter, and almost smooth. (Plate 133.)

A single tree of the juniper (*Juniperus communis*) formerly grew near the south shore of Staten Island, where it may have been planted; on hillsides from Poughkeepsie northward we find the low juniper (*Juniperus nana*) as a round shrub scarcely over three feet high.

Arbor-Vitae THUJA OCCIDENTALIS

The arbor-vitae, or tree of life, is popularly much confused with the white cedar. It may be readily distinguished by its cones which are oblong and composed of several loose scales, instead of being spherical and with more or less compressed scales. In other respects the resemblances are striking and the differences not very apparent.

In favorable situations it may reach a height of 60 ft. The trunk is continuous or sometimes divided, fluted and often conspicuously buttressed at the base. The horizontal branches frequently curve upwards at the tip. The small scale-like leaves are pressed closely to the frond-like, usually fan-shaped branchlets.

The flowers are usually reddish-brown, come out early in May and mature during the season. The cones are cinnamon-brown, ripen and shed their seeds in the autumn, but cling to the branches during the following winter.

Shingles, fence-posts and many other articles are made from the wood of the arbor-vitae, and the highly aromatic twigs and leaves are much prized. It grows in moist situations from New Brunswick to West Virginia and westward to Minnesota. It is common in the Highlands of the Hudson. Owing to its popularity for decorative planting it has become the progenitor of at least fifty different horticultural varieties.

White Cedar CHAMAECYPARIS THYOIDES

The white cedar, a tree from 70 to 80 ft. in height, is the swamp evergreen *par excellence.* It occurs from Maine to Florida and often forms exclusive forests; it grows in many parts of New Jersey. The horizontal branches which become more erect near the top give to the tree a spire-like conical shape. The branchlets are usually arranged in flat fan-like clusters and thus give a very characteristic appearance to the whole tree.

As in the red cedar there are two kinds of leaves; those on the young shoots are sharp-pointed, ridged on the back, and spreading from the stem. But the greater number of the leaves are pressed flat against the stem, are scarcely more than ½ inch long, and more scale-like than leaf-like. They turn russet brown during the winter and may drop off the second year but many of them cling to the branches for several years.

Unlike the red cedar, this tree has cones that are truly cone-like and not so compressed as to resemble berries. The cones are scarcely more than ¼ inch in diameter, almost spherical, gray-green at first but subsequently bluish-purple or reddish-brown.

The wood of the white cedar is not nearly so fragrant as that of the red cedar, but it is used in ship-building and for a variety of construction purposes.

Swamp Poplar POPULUS HETEROPHYLLA

The swamp poplar is common only in the southern part of the Hudson Valley. A few trees are known to grow in the Highlands but above this point it is rare. It grows plentifully along the Atlantic seaboard as far south as Georgia, and prefers moist or inundated situations.

In the north the tree is scarcely more than 50 ft. in height; in the south it is often twice this size. The trunk, which is covered with gray-brown bark, is mostly continuous, and bears towards the top the slender spreading branches. The leaf-blades, which are hoary when very young, subsequently become bright green and smooth. The leaf stalk is round, and consequently the leaves do not quiver in the breeze as they do in nearly all the other Hudson Valley poplars.

The flowers are of two kinds, those which subsequently produce fruit and those which do not. Almost always the two kinds are found on different trees, and they come out in April and May, usually before the leaves. The flower cluster, or catkin, is about 2 or 3 inches long. The fruits mature in May or June, and are filled with the seeds which are closely invested with silky, white or orange hairs.

The wood is of little economic importance, although under the name of black poplar it has been used in interior decorating and finishing.

Balsam Poplar POPULUS BALSAMIFERA

The balsam poplar, more or less of a swamp tree, occurs in the extreme northerly part of the Hudson Valley. It is known to be plentiful northward into Newfoundland and Hudson Bay, but becomes scarcer southward. It is a tall tree reaching a height of 100 feet and a trunk diameter of 4 feet. under favorable conditions. The bark and young twigs are reddish-gray; and the buds are conspicuously resinous.

Balm of Gilead POPULUS CANDICANS

The Balm of Gilead poplar, which may be distinguished by its bright green and smooth young leaves, with hairy stalks, is not known as a wild tree in the Hudson Valley. There are numerous specimens of this tree in the area but they are presumably derivatives of cultivated trees. The home of the Balm of Gilead is doubtful, but it has been stated to be Michigan and the country to the northwest.

Carolina Poplar POPULUS DELTOIDES

The Carolina poplar and the aspens may be readily distinguished from all the other native Hudson Valley poplars by their flattened leaf-stalks. To this flattening and consequent weakening may be traced the characteristic quivering of the leaves in the breeze.

The necklace poplar, as it is also called, is a tree rarely higher than 120 feet. The trunk is covered with smooth gray-green bark when young but in age the bark becomes rough and fissured. The branches are more or less spreading and stout. From the aspens of the Hudson Valley the Carolina poplar can be distinguished by its broadly triangular or delta-shaped leaf-blades, which are long-pointed at their tips. The flowers are so clustered as to form the familiar catkin, a peculiarity of all poplars. They bloom in April or May. Those catkins which subsequently bear the fruits elongate greatly after the blooming period.

The Carolina poplar grows best near water and it is found from Quebec to Florida and westward. It is common in the Hudson Valley.

The well-known Lombardy poplar (*Populus italica*) characterized by its rigidly erect branches, grows in the Hudson Valley only as an escape from cultivation. It is an Asiatic tree.

American Aspen POPULUS TREMULOIDES

The American aspen or quaking aspen is a tree occasionally reaching a height of 100 feet and a trunk diameter of 3 feet but in the Hudson Valley it is much smaller. The bark is pale yellow, becoming whitish. The spreading branches are remote, often contorted, and give the tree a round-topped outline.

The leaf-blades are dark green; oval in outline, with a rounded or wedge-shaped base and sharp-pointed tip. The teeth on the margin are small and have a tendency to be incurved. The leaf-stalk is flat and about as long as the leaf-blade. The gray-green flowers bloom in April and

May, followed by the fruits about a month later, when the stalk of the catkin becomes greatly elongated.

The American aspen is a rapid grower, and consequently the wood is soft and of little commercial importance, except as a source of paper pulp. Tannin is extracted from the bark. It grows best on moist gravelly soil or hillsides in the area, but it is found quite generally throughout the northern part of the continent. It is common along the upper Hudson, and extends southward to Staten Island.

Large-toothed Aspen POPULUS GRANDIDENTATA

The tree may be distinguished from the common aspen by its leaves which are broader than in the latter. The teeth on the margin of the leaf-blade are at least twice as large as those on the aspen, and they are not incurved. The buds of the aspen are usually quite smooth but in the large-toothed aspen they are uniformly clothed with dense hairs.

This tree prefers moist soil near swamps or streams, and it is confined to the eastern part of Canada and the United States. It is known to grow throughout the Hudson Valley.

Black Willow SALIX NIGRA

Most of the willows of the Hudson Valley are mere shrubs, but the black willow is a tree 30 to 40 feet high. There are a few more that very rarely become trees, although their characteristic habit is shrub-like. The bark of the black willow is dark brown or nearly black, but sometimes it is lighter brown tinged with orange. The branches are stout and spreading, giving the tree an open irregular head.

The leaves, which are alternately arranged on the reddish twigs, have lance-shaped blades from 3 to 6 inches long and are finely toothed on the margin. In age the leaf-blades may become scythe-shaped.

The flowers are clustered to form the well-known catkin. In the black willow they are found on short twigs, and bloom with the appearance of the leaves in early spring.

The wood of the black willow is of little use except for fuel. The tree is found usually at the edges of streams, and grows plentifully from New Brunswick to Georgia and westward.

The weeping willow (*Salix babylonica*) is common in the Hudson Valley. It is an Asiatic tree, however, and rarely establishes itself as a wild element in our flora.

The white willow (*Salix alba*) which is botanically related to the weeping willow, is a European tree that is as much at home in this country as our native willows. It may be distinguished from the black willow by its leaves, which are whitish beneath.

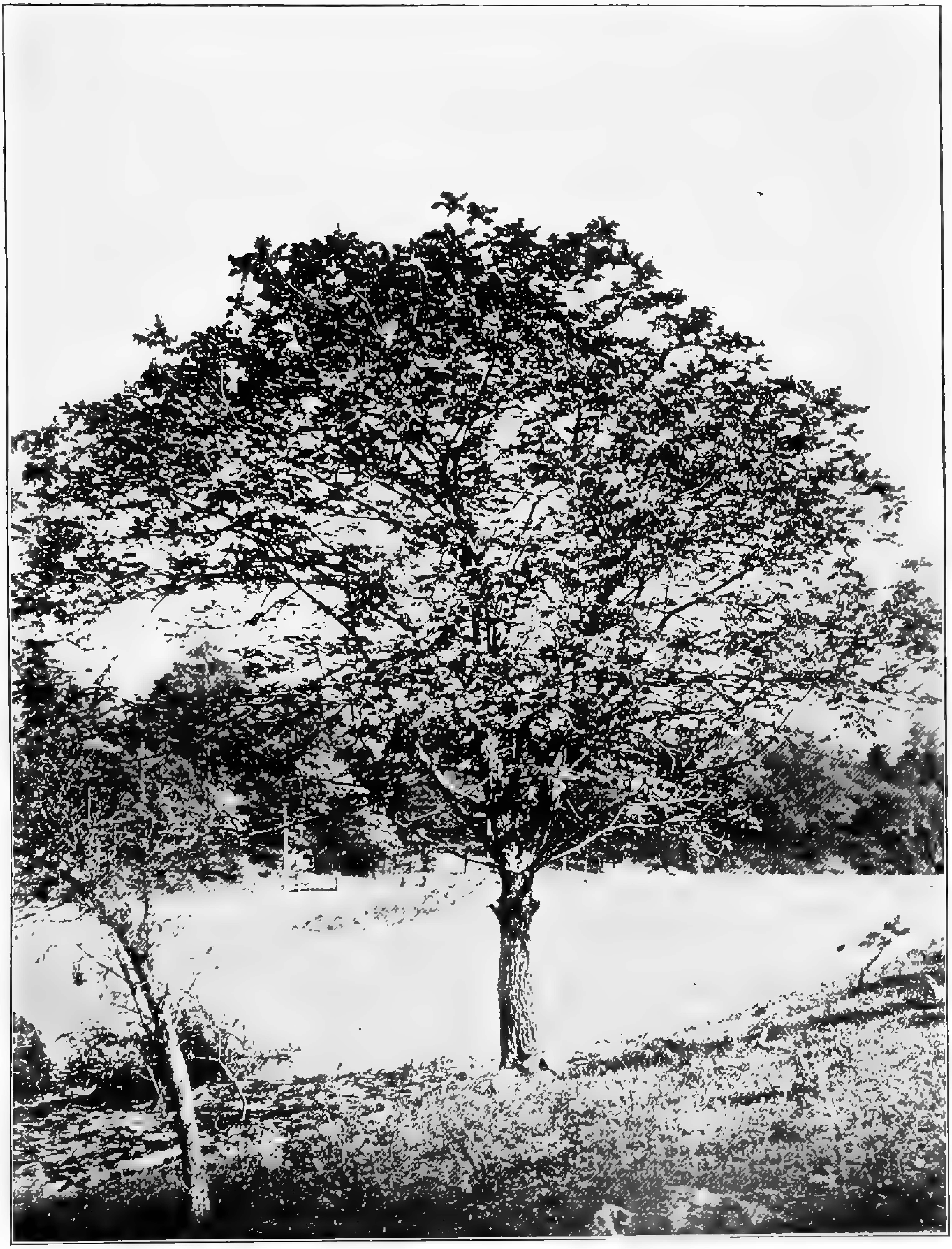
Butternut JUGLANS CINEREA

The butternut is a tree occasionally reaching a height of 80 feet in favorable situations. The trunk is scarcely ever continuous but divides about the middle and spreads out into several widely-spreading branches. The bark is usually brownish in color, coarse, and roughly fissured.

The leaves are compound, that is, they are composed of from 11 to 17 leaflets all attached to a common, hairy leaf-stalk. Each leaflet is more or less broadly lance-shaped and has an inequilateral base, which is attached directly to the common leaf-stalk, as the leaflets are themselves stalkless.

In the butternut the flowers bloom when the leaves are partly grown. They are in spike-like or catkin-like clusters. Those which are found in spike-like clusters subsequently develop into the fruits or "butternuts." The nut is oval-pointed, 4-ribbed and irregularly sculptured, and the sticky husk enclosing the nut is greenish and contains a violent yellow-green dye or stain.

The tree grows best in rich soil, either along streams or on low hillsides, and is found from Maine to Alabama and westward. It is common along the top of the Palisades and northward throughout the Hudson Valley, uncommon on Staten Island. It is of considerable economic importance for the wood is used in cabinet-making, the inner bark has



BUTTERNUT

New Baltimore, Greene County, N. Y.

medicinal properties and the outer bark yields a good sugar. (Plate 134.)

Black Walnut JUGLANS NIGRA

Closely related, botanically, to the butternut is the black walnut. It is taller than the former, frequently reaching a height of 130 feet. The bark is coarse and prominently ridged; and it is a darker brown than in the butternut. The leaflets on the black walnut are more numerous, frequently exceeding 20 to a single common leaf-stalk. They are unequal at the base, practically stalkless, and their margins are sharply small-toothed.

As in the butternut the flowers are arranged in catkins or in spike-like clusters. Those which subsequently develop the fruits are yellowish-green tinged with red. Unlike the butternut the fruit of the black walnut is never 4-angled or ribbed. It is almost perfectly round, the shell slightly sculptured, and covered with a thick husk.

The wood of the black walnut has become famous for its beautiful markings, the so-called figured trees being of almost fabulous value for the manufacture of furniture. Extensive forests of it once flourished throughout the eastern part of the United States, but it is now comparatively scarce. It grows in the vicinity of West Point and in the Highlands generally, southward to Staten Island, but it is less common than formerly.

Mocker-Nut Hickory HICORIA ALBA

In the autumn the mocker-nut will be found retaining its foliage longer than most other hickories. It is a tall tree, often reaching a height of 90 feet, and a trunk diameter of 3 feet. The trunk is usually continuous in the forest, but branched and forked when the tree grows in the open. The irregularly fissured close bark is characteristic and serves to distinguish it from the shag-bark hickories, where the bark is regularly fissured and splits off in large plates.

In the mocker-nut, as in all hickories, the leaves are compound, being composed of from 5 to 9 hairy leaflets, all attached to a common hairy leaf-stalk. The leaflets are oblong or lance-shaped, sharp-pointed at the tip, and wedge-shaped at the base. They are practically equilateral. In May or June the catkin-like flowers appear, followed in the fall by the well-known edible mocker-nut. The splitting of the husk of the mocker-nut serves to distinguish it from the pignut, in which the husk of the nut does not split.

The tree grows naturally from Maine to Florida, Nebraska and Texas, and it was at one time common on Manhattan Island. The hard, strong wood is indiscriminately classed with the other hickories by lumbermen.

Bitter-Nut HICORIA CORDIFORMIS

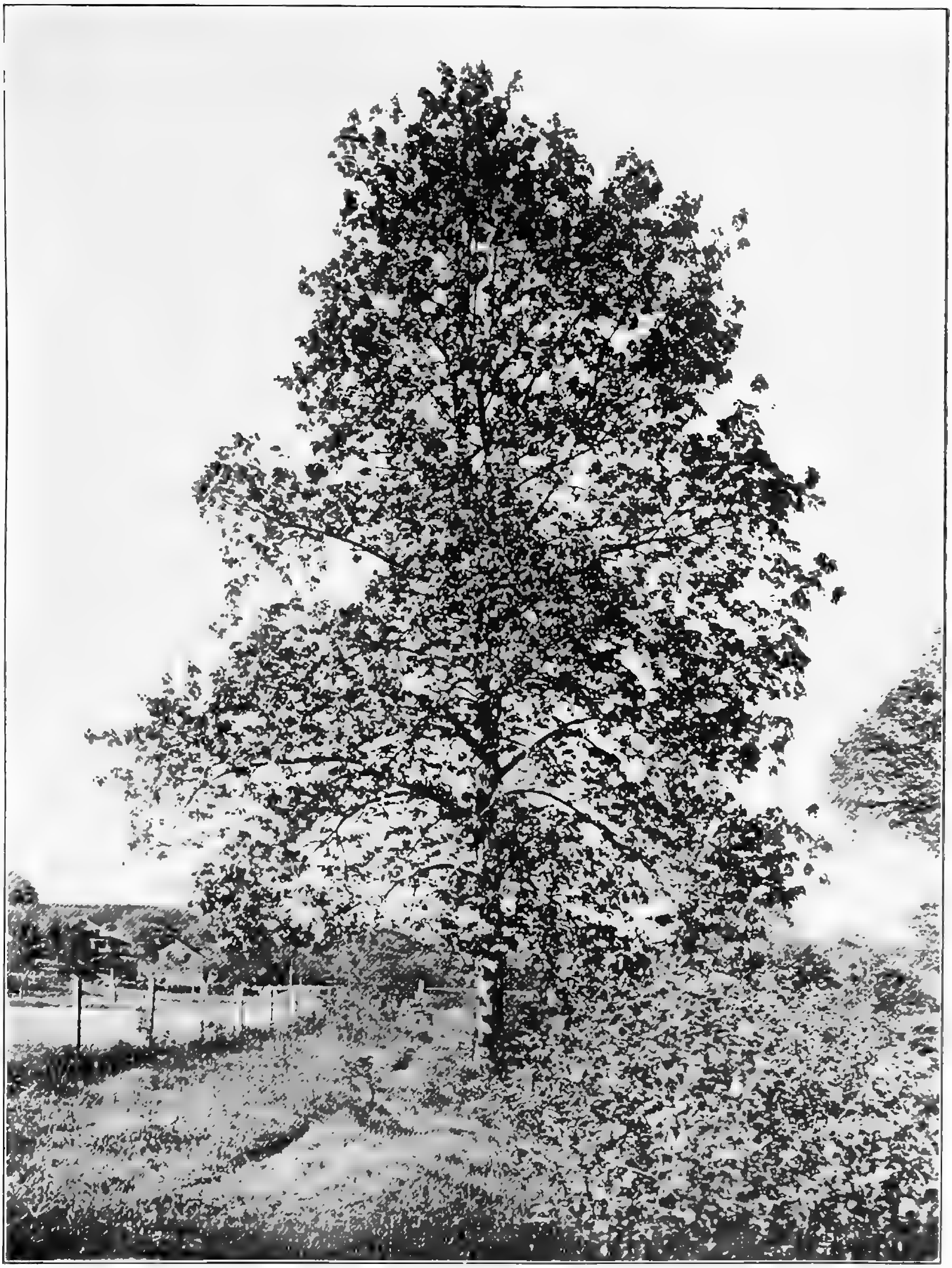
Because of its inequilateral and curved leaflets, the bitter-nut may be easily distinguished from the preceding, with which, in other respects, it might be confused. It is a tall, quickly growing hickory, quite commonly distributed from Massachusetts to Georgia and westward; and is found in fair abundance along the Hudson Valley. The wood is largely used for fuel, and also for making implement handles and hooks. Its thin-shelled nut is very astringent.

Shagbark Hickory HICORIA OVATA

In the Hudson Valley the shagbark, or shellbark as it is sometimes called, is one of the two hickories in which the bark splits off in long plates. The whole trunk is covered with the pieces of bark clinging at their upper edges and free from the trunk at the lower, thus giving the trunk its strikingly shaggy appearance.

It rarely reaches a height of 100 feet, and usually does not have a trunk diameter of more than 2 to 3 feet.

There are usually only 5 leaflets in this kind of hickory, but sometimes 7 leaflets may be found. The leaflets are almost equilateral, and wedge-shaped at the base. The catkin-like flower clusters come out in May followed by the fruits in the fall. The nut, which is the common hickory



SHAGBARK HICKORY

New Baltimore, Greene County, N. Y.

nut of commerce, is slightly flattened at the top, 4-sided and closely invested with a husk which splits all the way down to the base.

The range of this valuable tree is from Maine to Georgia; in the Hudson Valley it is common. The hard tough wood is much prized in making tool handles. (Plate 135.)

Small-fruited Hickory HICORIA MICROCARPA

There are two Hudson Valley hickories that have shaggy bark. The small-fruited hickory may at once be distinguished by the husk of its smaller nut which does not split all the way to the base, as it does in the common shagbark hickory. The splitting plates of the bark are smaller, and consequently the trunk is not so distinctly shaggy.

The small-fruited hickory, which is a large tree, often reaching a height of 80 feet, grows commonly in the same situations as, and often with, the shag-bark hickory; it is known to occur only from New York to North Carolina and westward to Missouri. It is comparatively common on Staten Island but scarcer northward. (Plate 136.)

Pignut Hickory HICORIA GLABRA

The pignut prefers drier ground than most of the other hickories. It is often as much as 100 feet in height and with a trunk diameter of 3 to 4 feet. The bark is close, sometimes shallowly fissured, and is usually of a grayish color.

The compound leaf is composed of 3 to 7 leaflets; very rarely 9 leaflets will be found. Being practically without individual stalks, the leaflets are attached by their bases to the common leaf-stalk of the leaf. The leaflets are smooth above, and smooth below except at the forking of the principal veins where a tuft of hairs may often be found. The tree flowers in May, and the fruits develop about October. The nut, which is the common, and usually bitter, pignut of the markets, is almost spherical, sometimes slightly compressed and is closely invested by a husk which splits very tardily, if at all.

From New York to Florida and westward is the natural home of the pignut and it is common along the Hudson Valley.

American Hornbeam CARPINUS CAROLINIANA

Of all the native trees of the Hudson Valley the wood of the hornbeam is undoubtedly the hardest and least easily worked. The tree is never more than 30 to 40 feet in height and the trunk is covered by a close-fitting, smooth, bluish-gray bark. The tough, spreading branches, together with the trunk, are often fluted and have a characteristic sinewy appearance.

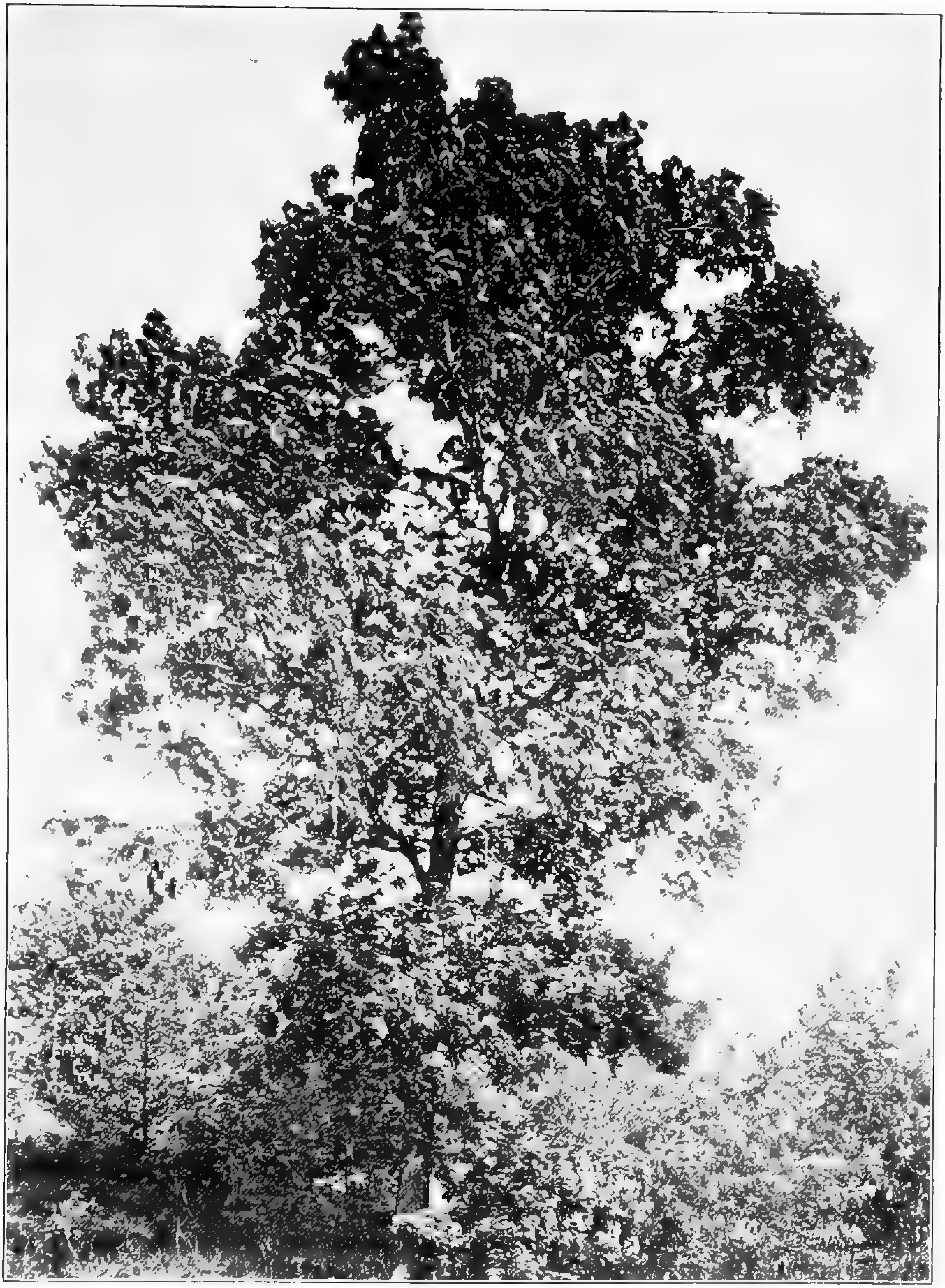
The oval or oblong, sharp-pointed leaf-blades are dull green in color, from 2 to 5 inches long, and coarsely toothed. On the upper side the veins are deeply impressed, thus making the leaf-blade distinctly roughened. The leaf-stalk is hairy and slender, and scarcely more than ½ inch long.

There are two kinds of flowers on the hornbeam, those which subsequently develop into the fruits and those which do not. Both kinds are arranged in catkins, and bloom before the leaves expand, usually in April. The fruit is a small nut, scarcely more than ⅛ inch in diameter, which is enveloped in a flat 3-lobed miniature leaf. Sometimes one or both of the lobes of this small leafy envelope may be wanting.

In moist bottom lands and often associated with the red maple, the hornbeam is in its natural element, although it is sometimes found in drier situations. The tree grows freely from Maine to Florida and westward, and is very common in the Hudson Valley.

Hop Hornbeam OSTRYA VIRGINIANA

Although the wood of the hop hornbeam is almost as hard as the American hornbeam it is more easily worked, and is used for making mallets, handles of tools and other implements. Unlike the American hornbeam the bark of this tree is rough, and distinctly, but closely, fissured or roughened.



SMALL FRUITED HICKORY

New Baltimore, Greene County, N. Y.

The tree rarely attains a height of 60 feet. The oblong-pointed leaf-blades are coarsely toothed on the margin, and furnished with conspicuous tufts of hair on the under side at the juncture of the principal veins. A small tuft of hair tips the marginal teeth, when the leaves are very young.

Before the tree becomes covered with foliage, the catkin-like clusters of flowers bloom. The fruits follow, usually maturing during the summer. The fruit consists of a small nutlet completely enclosed by a bladder-like structure, and in this it differs from the American hornbeam in which the nutlet is surrounded by a small leaf-like wing.

This tree prefers dry gravelly slopes and ridges and is found growing wild from Cape Breton to Florida and westward. It is common in the upper Hudson region particularly near the country bordering the Catskills, becoming scarcer southward.

Gray Birch BETULA POPULIFOLIA

The brilliant white bark of the gray birch and paper birch serves at once to distinguish them from all the other Hudson Valley birches. In the gray birch, or white birch as it is often called, there are usually 2 to 5 trunks in a cluster. The tree rarely exceeds 40 feet in height.

The poplar-like leaves of the gray birch serve to distinguish it from the other white-barked birch. In the former the leaf-blades are delta-shaped and the tip of the blade runs out into a fine point. They are usually 2 to 3½ inches long, somewhat heart-shaped at the base, and the margins are coarsely toothed; these large teeth are themselves more finely toothed.

About the time the leaves unfold the catkin-clustered flowers bloom, followed subsequently, in the fertile flowers, by the fruits. These are a collection of scales, each scale enclosing a small winged seed.

Many common articles are made from the gray birch and it is extensively used in making charcoal. The tree occurs freely from Quebec to Pennsylvania and Ontario. It is common along the Hudson.

Paper Birch BETULA PAPYRIFERA

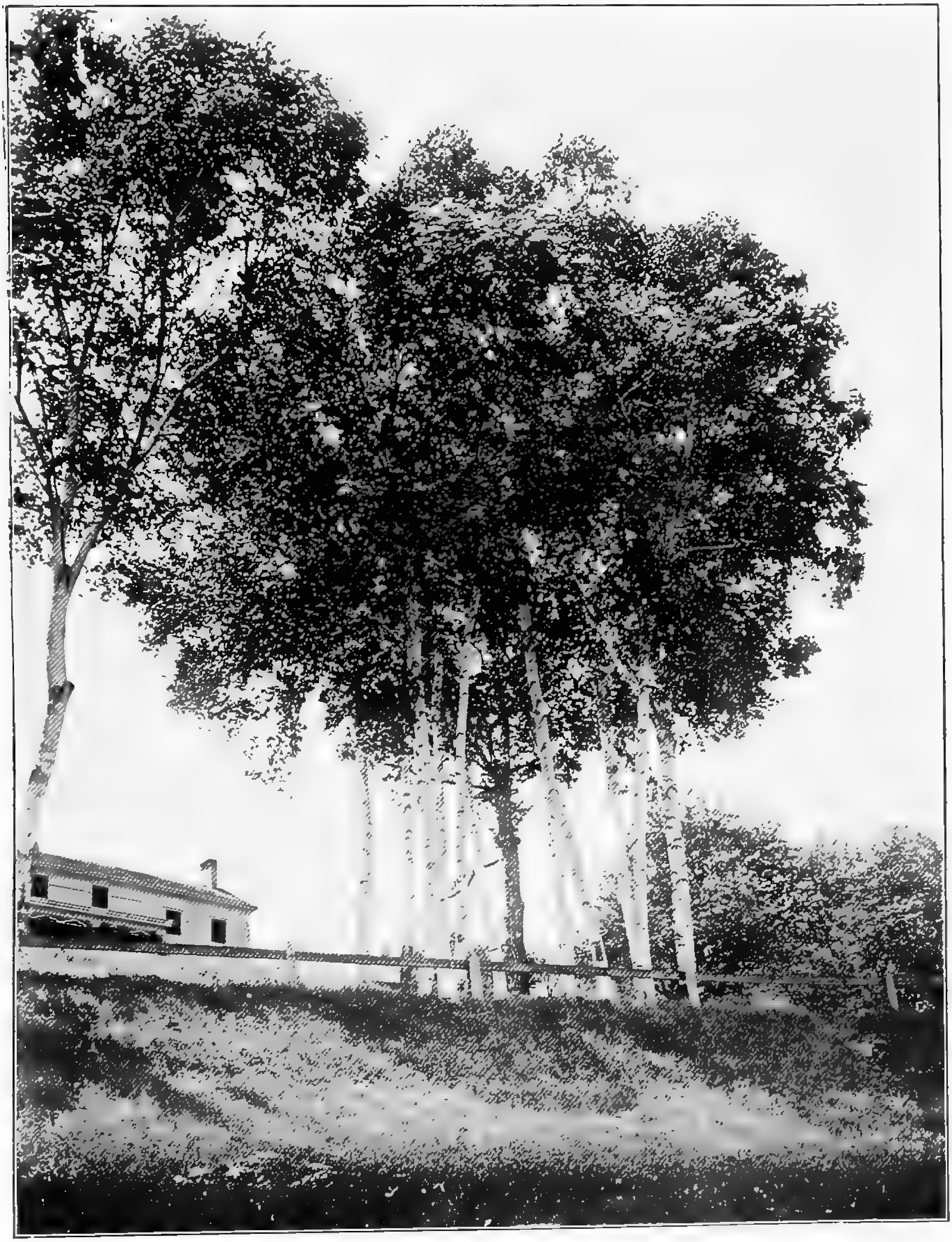
The familiar birch-bark canoe of the Indian was made from the impervious bark of this paper- or canoe-birch, as it is often called. As in the gray birch the bark is white, but often the lower part of the trunk of the paper birch becomes darker colored, particularly when the tree is old. In the Hudson Valley the tree is seldom over 80 feet in height.

The oval-shaped leaf-blades with the margin irregularly but not coarsely toothed, serve to distinguish this tree from the preceding. From 2–4 inches is the usual length of the leaf-blade, and the top sometimes runs out into a fine point. In April and May the flowers open, either with or before the leaves. The sterile, non-fruiting catkins are usually clustered in twos or threes, but the fruit producing catkins are mostly solitary. The fruits are somewhat similar to those of the gray birch.

From Labrador to Alaska, southward to New Jersey and northern Montana is the natural range of the paper birch. It occurs sparingly southward and is known to grow along the Hudson Valley near the Catskills. (Plate 137.)

River Birch BETULA NIGRA

From all the other birches of the Hudson Valley that have dark colored bark the river birch may be distinguished by its lack of an aromatic sap. The other dusky-barked birches all have the characteristic odor of birch-beer and other derivatives of their wintergreen-flavored sap. Under favorable conditions the river birch attains a height of 80 or 90 feet, and if growing in the open it develops into a freely branching, oblong-outlined tree. The reddish-brown bark is thick and irregularly segregated into small scales. The leaf-blades are sharp-pointed at the tip, oval in outline, and either wedge-shaped or blunt at the base. They are dark green and shining above and woolly on the veins beneath. In April and May the catkin-like flowers bloom, followed in June by the fruits.



PAPER BIRCH

New Baltimore, Greene County, N. Y.

Various kinds of woodenware are manufactured from the wood of the river birch, and it is used for fuel. As its name indicates it prefers moist places along river banks, and it grows wild from Massachusetts to Georgia and westward. In the Hudson Valley it is known to grow near the Catskills, and southward to Staten Island.

Cherry Birch BETULA LENTA

Birch-beer, betul-oil and a flavoring extract, all of which are derived from the aromatic sap of the cherry birch, make it the best known of all the native birches. Under favorable conditions the tree often attains a height of 70 feet, and it is more or less symmetrically ovoid in outline. The nearly black bark of the tree has suggested the name of black birch, and it is known by this name in many places. The name sweet birch is derived from its aromatic sap. The oval-oblong leaf-blades are from 2½ to 5 inches long, sharp-pointed at the tip, and more or less heart-shaped at the base. The margins are sharply but not coarsely toothed.

Sometime before the leaves appear the tree is covered with its drooping and erect catkins of flowers. The pendulous non-fruiting kind are golden-brown, when mature, and the blending of these golden flowers with the reddish twigs produces beautiful color harmonies in the early spring. The erect, fertile catkins produce the fruit about two months after the flowers reach maturity. As in all the birches the seeds are prominently winged.

The cherry birch is confined to the region from New Brunswick to Georgia and Iowa. It is exceedingly common throughout the Hudson Valley.

Yellow Birch BETULA LUTEA

Although it has many characteristics in common with the cherry birch, the yellow birch can generally be identified by its yellowish or reddish-yellow bark. It is a tree sometimes as high as 90 feet and in the open it develops a broad rounded top. The bark of the branches and branchlets and sometimes of the trunk peels very readily and the curled up edges of these peelings give a very characteristic appearance to the whole tree.

Unlike the cherry birch, the oval-shaped leaves of this kind, are coarsely toothed and the larger teeth are themselves more finely toothed. It can be distinguished from the river birch by its stalkless catkins of flowers. In the latter sort the catkins are always stalked. The sterile catkins are usually found in clusters of from 2 to 4. The fertile, or fruit-producing catkins are always solitary and usually fastened to the twig at its juncture with a leaf-stalk.

Agricultural implements, woodenware and furniture are all made from the wood of this tree. It grows wild from Newfoundland to North Carolina and westward, and is found along the upper Hudson.

Southern Yellow Birch BETULA ALLEGHANENSIS

This is related to both the cherry and the yellow birch. It is smaller than the latter and about the same size as the former. The bark on the trunk is sometimes peeled and sometimes merely fissured. It is usually of a reddish-yellow color.

The fertile catkins of this birch are scarcely more than ½ inch long and more or less oval or globose-oval in outline. In the common yellow birch they are elliptic in outline and longer than those of this tree.

Lumbermen use the wood of this birch indiscriminately with that of the yellow birch and for like purposes. It grows in woodlands from Massachusetts to southern New York and westward. Trees of this birch are known to grow in the Highlands of the Hudson, and, when better known, it will doubtless be found elsewhere.

New York Alder ALNUS NOVEBORACENSIS

Nearly all the alders are typically shrubs, but specimens of this species are sometimes distinctly tree-like. So far as known the tree grows only on Long Island and Staten Island.

The tree is some 25 feet high, having a trunk covered with a smooth brownish bark, and young brownish hairy twigs. The thin leaves are more or less oval in outline from 3½ to 5 inches long, and acute at both ends, or sometimes they may be bluntish at the tip. The flowering catkins are of two kinds, sterile and fertile. The latter produce the fruits which cling to the branches throughout the following winter. The nut is winged.

Our native alders are of little economic importance.

American Beech FAGUS GRANDIFOLIA

Its smooth, bluish-gray bark, silky-golden buds and its lustrous green leaves, which turn bright yellow in autumn, all make the beech one of the most distinctive and beautiful trees of the American continent.

It sometimes surpasses 100 feet in height and the trunk often exhibits a tendency to be fluted. The leaf-blades are oblong or oval-oblong, rough and with numerous veins, some of which terminate in the coarse marginal teeth. The flowers appear after the leaves unfold. Those which do not produce fruit are arranged in catkins and the fertile flowers are found usually two together on a short stalk. They have practically no petals. The fruit is a small nut completely surrounded by a prickly shell-like husk which splits and thus releases the seed.

The wood of the beech is much used for a variety of purposes and particularly in the manufacture of creosote. The kernel of the nut is sold in the Canadian market. The tree is confined to the eastern half of the continent and is common in the Hudson Valley.

The copper beech, a dark-leaved form of the European beech (*Fagus sylvatica*), is much planted for ornament, but it is not known to have established itself as a wild element in out native flora.

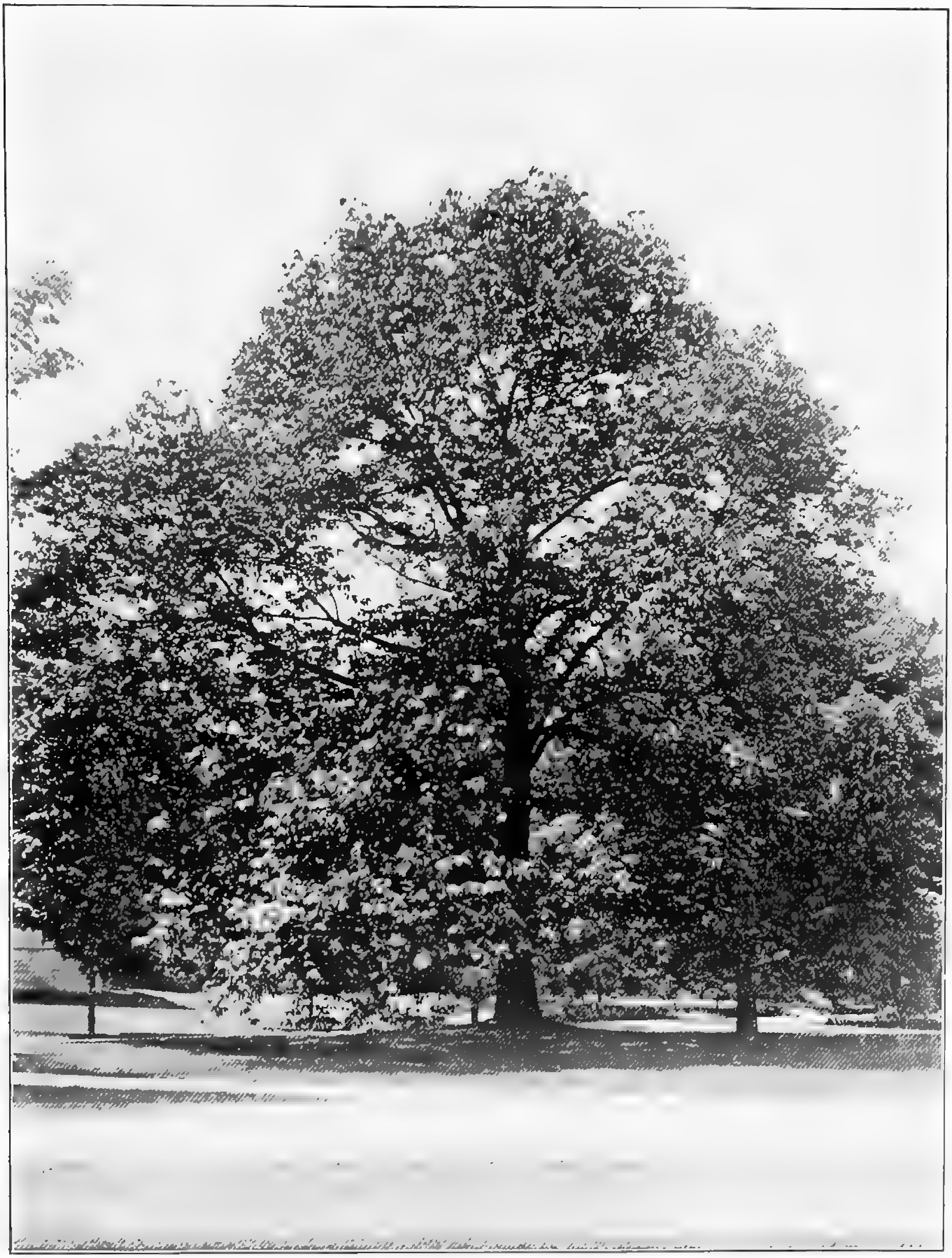
American Chestnut CASTANEA DENTATA

Most of the chestnut trees in the Hudson Valley are affected by a fungus disease that has failed to yield to the ordinary methods of fighting tree-diseases. If the disease keeps up its present activity, a few years hence will see the practical extinction of one of the largest and most useful trees of North America. In the open it often forms a round-topped tree more than 90 feet across. The trunk is closely invested with a coarse, deeply fissured bark, and is often as much as 10 feet in diameter. The lance-shaped or elliptic leaf-blades are sometimes as long as 8 inches and are furnished with coarse, sharp-pointed marginal teeth. Usually about the Fourth of July the tree is covered with its golden-brown catkins of flowers, making the tree a conspicuous feature of the landscape. The upper part of most of these catkins is sterile but the lower part of them subsequently develop into the well-known chestnut.

The chestnut is known to grow only east of the Mississippi and from central New York to Georgia. It is, or was, common throughout the Hudson Valley. The wood is of great economic importance and the bark is extensively used in the tanning of leather. (Plate 138.)

Red Oak QUERCUS RUBRA

Although the wood of the red oak is inferior to that of the white, it is largely used for interior decorating. The tree sometimes reaches a height of 130 feet with a trunk diameter of 5 feet. The stout spreading branches give the tree a broad round-topped outline. At first the young twigs are greenish becoming successively reddish and brown. The thin leaf-blades are green both sides, lobed about halfway. to the middle of the blade, and the divisions are always tipped with a strong bristle. As in all oaks the flowers are of two kinds, sterile and fertile. In the red oak the sterile are arranged in catkin-like clusters, and the fertile are usually solitary or in twos. The latter subsequently develop into the well-known acorn. In this oak the acorn is oval but with



AMERICAN CHESTNUT

Vassar College Campus, Poughkeepsie, N. Y

a flat base, and usually ¾ to 1¼ inches long. The base is surrounded by a flat saucer-shaped cup, which is hairy on the inside.

The red oak is found growing wild from New Brunswick to Georgia and westward. It is common throughout the Hudson Valley.

Swamp Oak QUERCUS PALUSTRIS

The coarse, rough wood of this oak make it undesirable for the fine work for which the wood of the red oak is used, and consequently it is used mostly for making shingles and clap-boards, and in rough construction work. On the whole it is a smaller tree, and has a more restricted distribution, although it is exceedingly common throughout the Hudson Valley.

The reddish, close bark is often scaly and split into small plates which are flattened against the trunk. The greenish young twigs turn reddish-brown when old. The blade of the leaf is oblong in general outline, but the bristle-tipped lobes divide it almost to the center. At its base the leaf-blade is narrowly or sometimes broadly wedge-shaped. The drooping lower branches, especially in older trees, are exceedingly characteristic.

The widely cultivated swamp oak has acorns decidedly different from those of the red oak. They are short-stalked, solitary or in small clusters, and nearly hemispherical; scarcely ever more than ½ inch in diameter. The cup encloses only about one quarter of the acorn, and it is hairy on the inside. (Plate 139.)

Black Oak QUERCUS VELUTINA

A conspicuous charactertistic of the black oak serves as a ready means of distinguishing it from all the other bristle-tipped sorts. The inner bark, easily disclosed by cutting in about an inch, is of a bright orange color. It is the titular head of all the bristle-tipped kinds, as they are often collectively known as the black oaks, and in this species the name is well taken for the bark is very dark in color, almost black.

The leaf-blade is ovate in general outline, but its lobes divide the blade almost halfway to the middle. From its wedge-shaped base to the bristle-tipped apex the blade is sometimes as long as 10 inches, and the veins and sometimes the whole surface of the leaf-blade is hairy. When the leaves are about half unfolded the flowers appear, followed subsequently by the acorns. These are solitary or in pairs, often striped, or covered with fine reddish hairs. The cup encloses almost half the nearly globose nut.

For ordinary construction purposes the wood of the black oak is of very little value. The bark, however, is used as a yellow dye and in tanning leather. The tree grows freely from Maine to Florida and westward, and is common throughout the Hudson Valley. (Plate 140.)

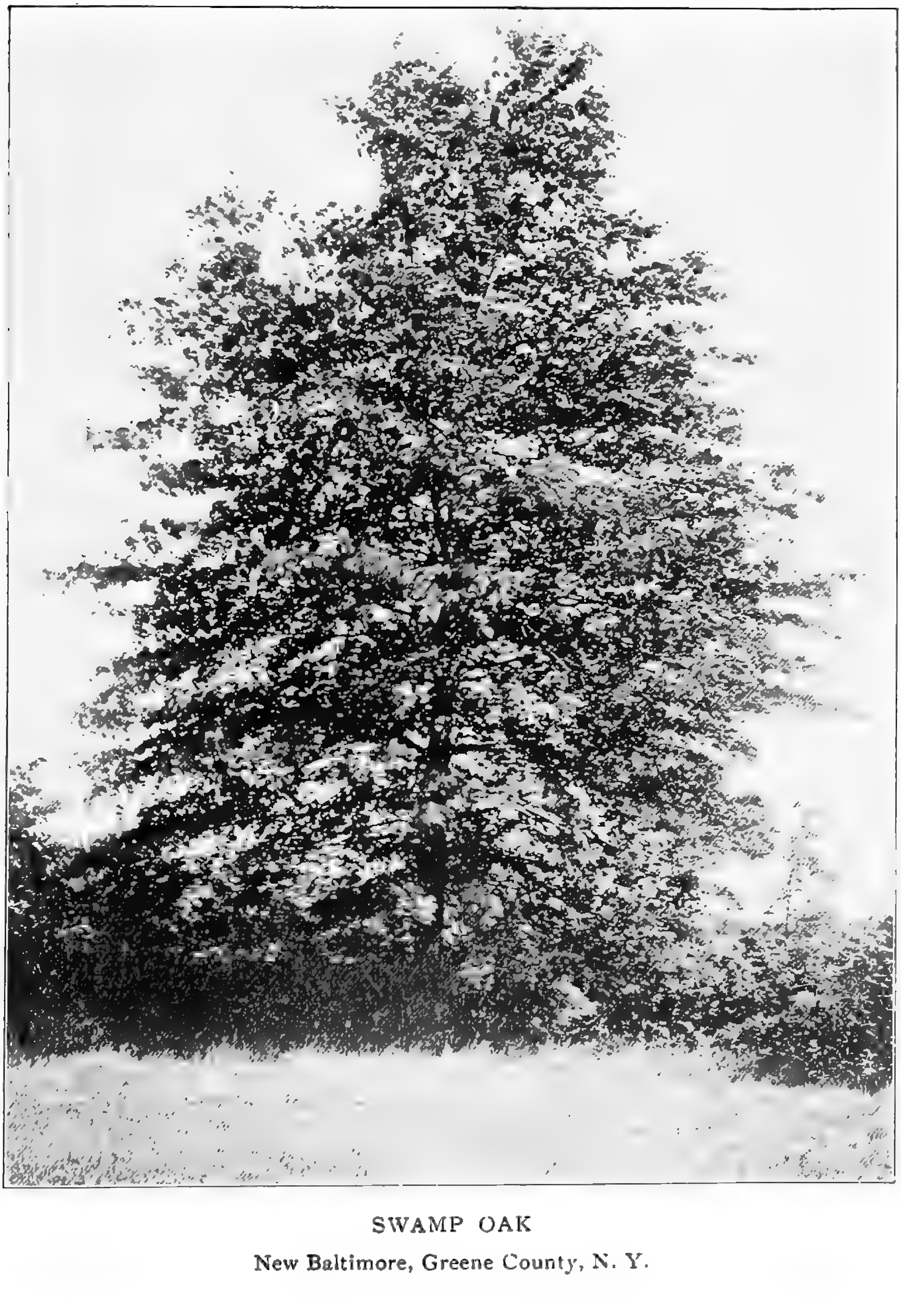
Gray Oak QUERCUS BOREALIS

This little-known oak occurs sparingly in the northern part of the Hudson Valley, and also in the mountains as far south as the Carolinas. It has some characteristics in common with the red and scarlet oaks; its acorns have flat saucer-shaped cups, similar to those of the red oak. One characteristic that may distinguish it from these trees is the fact that its leaves usually hang on longer in the autumn than do the leaves of the red and scarlet kinds. The tree is difficult to identify. The gray oak is alleged to grow further north than any other oak.

Scarlet Oak QUERCUS COCCINEA

This tree takes its name from the brilliant scarlet coloring of its young leaves and the magnificent coloring of its autumnal foliage. When mature the leaves become bright green and shining. The tree often attains a height of 70 feet and a trunk diameter of 3 feet.

The broadly oval leaf-blades are divided almost to the middle by their lobes which are from 5 to 9 in number and



SWAMP OAK

New Baltimore, Greene County, N. Y.

always bristle-tipped. From the blunt base to the acute, bristle-tipped apex the blade is usually from 5 to 8 inches long. On the under side of the blade they are paler than on the upper, and often furnished with tufts of rusty-colored hairs at the juncture of the more prominent veins. The flowers appear when the leaves are half unfolded, followed in the autumn of the second season by the acorns. These are practically stalkless, solitary or two in a cluster. The acorn is ovoid, from ½ to ¾ of an inch in length, and enclosed for ⅓ or ½ of its lower part by the cup.

The scarlet oak grows best in dry sandy situations from northern New York to Georgia and westward to Iowa. In the Hudson Valley it is a fairly common tree. Its wood, which resembles that of the red oak, is used for much the same purposes, but is not so valuable.

Black-Jack Oak QUERCUS MARILANDICA

From all the bristle-tipped oaks that have lobed leaves the black-jack oak can be easily distinguished by its peculiar leaf-blades. They are much broader above the middle than below it. In the Hudson Valley it is found only on Staten Island and adjacent Long Island and New Jersey. Further south it reaches a height of 40 feet.

The leaf-blades which are narrowed at the base, and conspicuously widened upward, are from 3 to 6 inches long. There are mostly three blunt, but bristle-tipped lobes, at the apex of the blade, which on the under side is usually covered with short brownish hairs. In April or May the flowers appear followed in the autumn of the second year by the acorns. These are hemispherical and from ½ to ¾ inch long, and enclosed for their lower half by the thin cup.

The wood of the black-jack oak is little used except for fuel and in the manufacture of charcoal. The tree has much value for decorative planting, but is of very slow growth.

Willow Oak QUERCUS PHELLOS

The popular name willow oak is truly descriptive of this tree. It has the leaves of a willow and it is the only Hudson Valley bristle-tipped oak that is entirely without lobing in the leaves. The tree prefers rich bottom lands and its northern limit of growth is in the southern extremity of the Hudson Valley. On Staten Island there are some big trees of the willow oak.

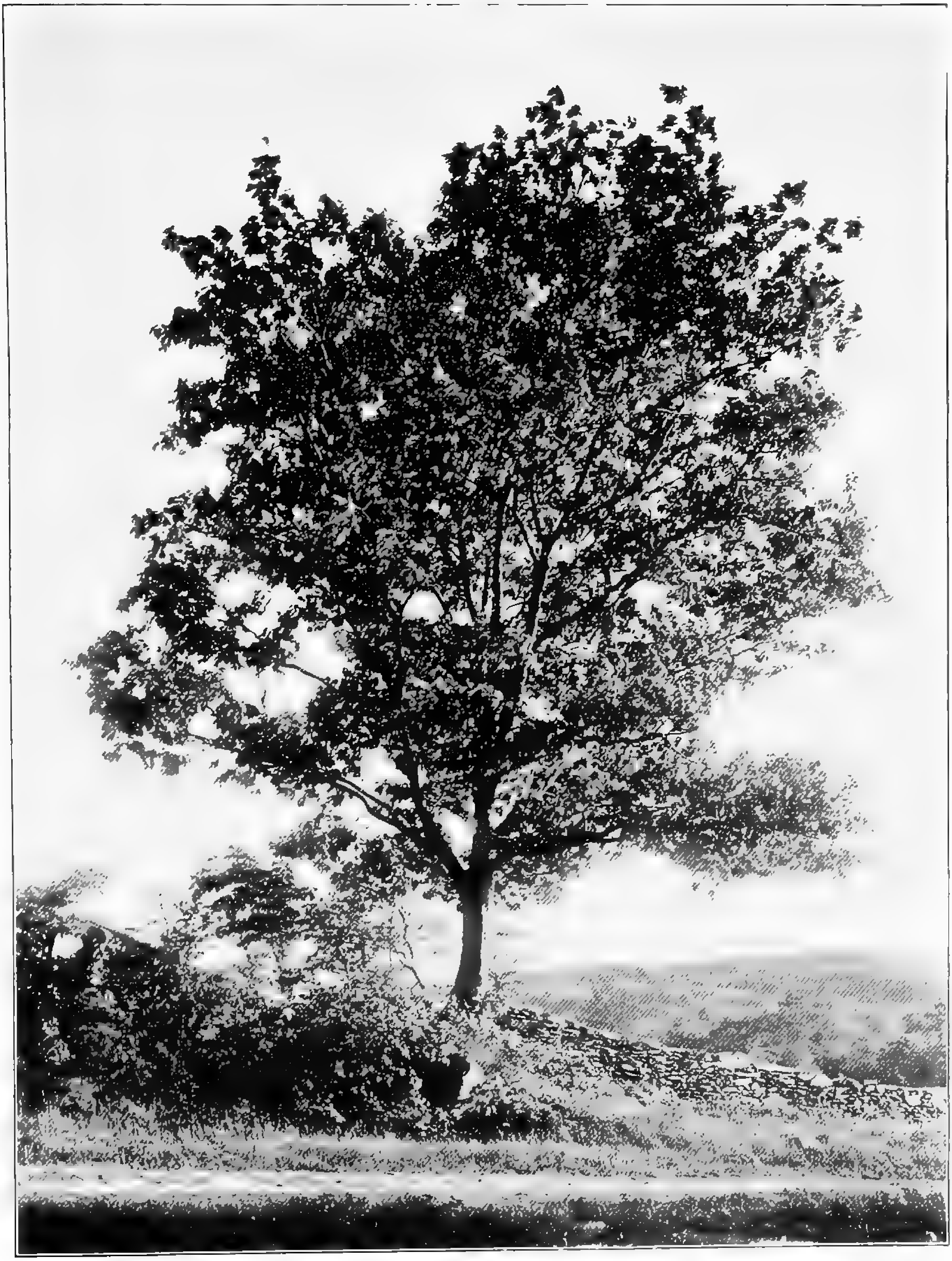
The lance-shaped leaves closely resemble a typical willow leaf, and are from 2 to 5 inches from the sharp-pointed base to the bristle-tipped apex. In texture the leaf-blade is thick and leathery. Soon after the leaves unfold the flowers appear, followed in the second season by the acorns. These are mostly solitary, almost round and not more than ½ inch in diameter. Only the base of the acorn is enclosed by the reddish-brown cup, which is hairy on the inside.

The wood is used sparingly in the manufacture of wagons, but the tree is valuable for ornamental planting from Philadelphia southward.

Yellow Oak QUERCUS MUHLENBERGII

The chestnut oak is also one of the names used for this tree and it is well chosen for the leaf is something like the chestnut leaf. In the most favorable situation the tree may be as high as 160 feet, but in the Hudson Valley it is never so tall as this. The bark is light brown and the twigs, at first green, become dark brown in age. The oblong, lance-shaped leaf-blades are from 4 to 8 inches long, sharp-pointed at both ends, and with several small marginal lobes or roundish teeth. The lobes and tip of the blade are not bristle-tipped. In the spring, appearing with the leaves, the flowers come out, followed in the succeeding autumn by the acorns. These are practically stalkless, solitary or two in a cluster. The nut is ovoid, ½ to ¾ inch long and its lower half enclosed by the woolly cup.

The wood of the yellow oak is very hard, not easily seasoned, and is mostly used for rough construction work,



BLACK OAK

New Baltimore, Greene County, N. Y.

such as railroad ties and fencing. The tree grows naturally from New York to Alabama and westward. It is common in the Hudson Valley particularly in the Highlands.

Alexander's Oak QUERCUS ALEXANDERI

This oak is rare in the Hudson Valley. Trees have been observed at West Point and Hyde Park, but it is doubtful if it is found south of these points. It is otherwise known from Vermont to Michigan and Iowa. From the yellow oak, to which it is botanically allied, it can be distinguished by its leaf-blades which are broadest above the middle, and have shallow lobes or teeth. The cup of its acorn encloses only the base of the nut, in contrast to the yellow oak where the nut is half enveloped by the cup; its bark is somewhat flaky.

Rock Chestnut Oak QUERCUS PRINUS

As in the two preceding kinds this oak has leaves that strongly resemble the leaf of a chestnut. The trunk often becomes forked a short distance above the ground and the tree is often as high as 70 feet. The exceedingly coarse deeply-fissured bark is used in tanning leather. The oblong or lance-shaped leaves are from 6 to 8 inches from the narrow base to the equally narrowed apex. Neither the tip of the blade nor the numerous, rounded marginal teeth are bristle-tipped. When the leaves are about one third unfolded the flowers appear, followed subsequently by the acorns. From the other chestnut oaks this sort differs in having its acorns at the end of a stout stalk. The nut is ovoid or oblong and from 1–1½ inches long; its lower half is enclosed by the hairy cup.

The hard, close-grained wood is hard to cure and is used mostly for railroad ties, fencing and so forth. The tree is confined to a wide belt ranging from central New York to Georgia, and as its name implies prefers rocky situations; it is common in the Hudson Valley.

Swamp White Oak QUERCUS BICOLOR

This oak often attains a height of 90 feet in the forest but isolated specimens are usually lower and broader. The tortuous branches and trunk are invested by a red-brown, scaly bark, which on the trunk is deeply furrowed with confluent fissures.

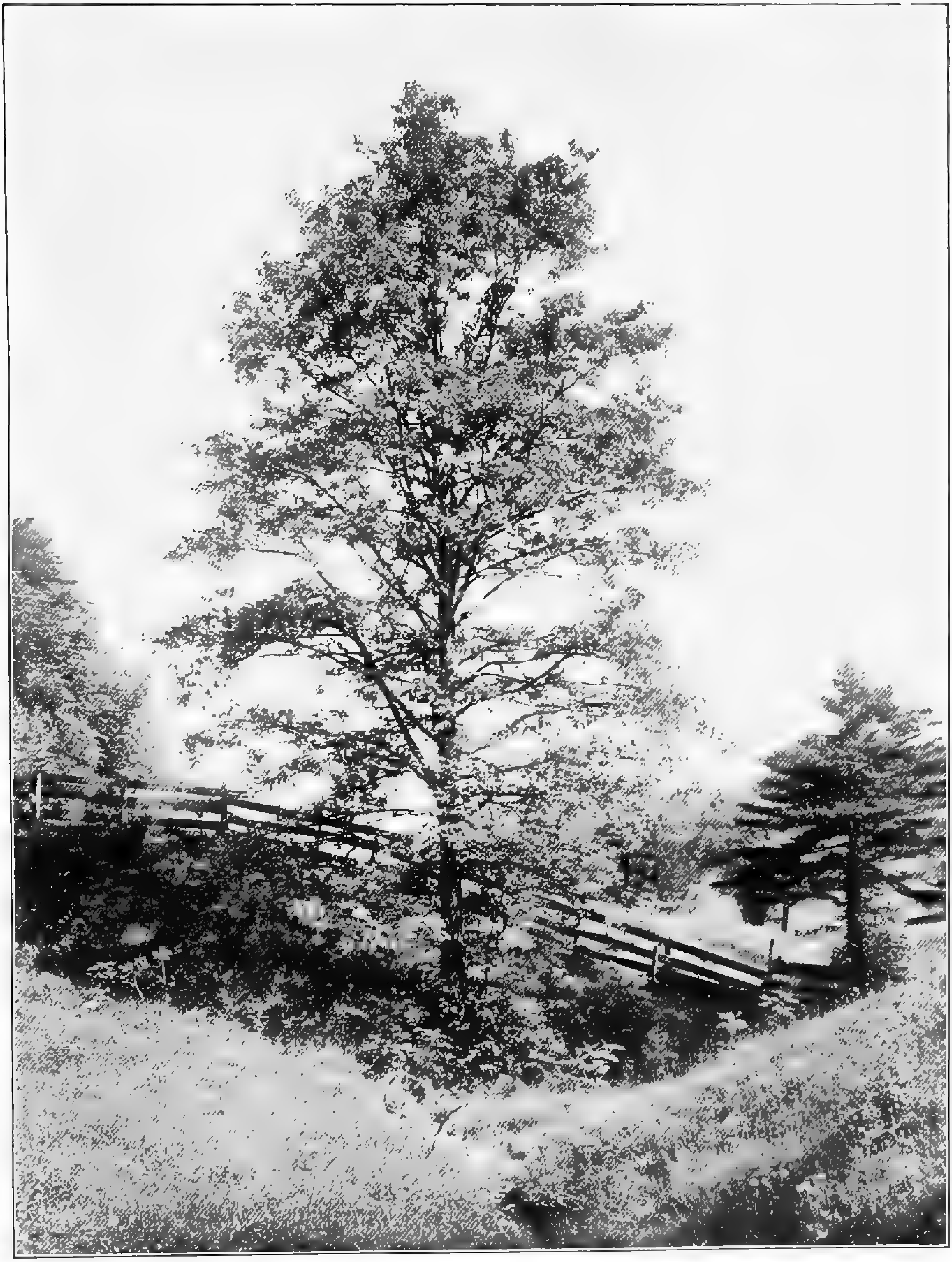
The leaf-blades are lobed, but not deeply so, and in general outline the blade is broadest above the middle. Neither the lobes nor the apex of the blade are bristle-tipped. The leaf-blades are green above and more or less woolly and pale beneath. In April or May the flowers appear followed in the succeeding autumn by the fruit. The nut is slender-stalked, ovoid, about ¾ of an inch long and its lower half is immersed in the woolly cup.

The tree prefers moist places and is found from Quebec to Georgia and westward. Its wood is sold indiscriminately by lumbermen for the same purpose as white oak and it is exceedingly valuable.

Bur Oak QUERCUS MACROCARPA

In some situations this tree attains a height of 170 feet, but it never becomes as tall as this in the Hudson Valley where it is local and found only in the northern part. The brown or reddish bark is deeply fissured and split into irregular plates.

The upper half of the leaf-blade is broader than the lower half and divided almost to the middle by the lobes. The terminal lobes are longer than the lateral ones, and are coarsely blunt-toothed. Neither the apex, lobes nor teeth are bristle-tipped. The upper surface of the leaf-blade is smooth and green, the lower grayish and hairy. According to the latitude the flowers appear from March to June, in the Hudson Valley early in May. The stalkless fruits mature the same autumn, singly or in clusters of 2 or 3. The nut is almost round or sometimes oblong, and varies from ½ to 2 inches long according to latitude. It is about half immersed in a cup which is conspicuously fringed at the



BUR OAK

New Baltimore, Greene County, N. Y.

upper edge. This fringe or burr on the cup gives the tree its name and serves to distinguish it from all the other oaks in the Hudson Valley.

Commercially the tree is very important, its wood being used for a variety of purposes. It occurs from New Brunswick along the mountains to Tennessee and westward, where it reaches its greatest development. (Plate 141.)

Post Oak QUERCUS STELLATA

The post oak reaches its northernmost limit on Staten Island and the adjacent territory in New Jersey and Long Island. It does not attain its full dimensions in this region and never reaches 100 feet in height, a stature credited to it in southern Ohio. The flat-ridged bark is coarse, and grayish-brown in color.

A peculiarity of its foliage furnishes the reason for the name *stellata,* meaning star or star-like. The leaves are closely clustered, which, with their deep lobing, give the leaf clusters enough resemblance to a star to make the name appropriate. The divisions of the leaf-blade extend almost to the middle, and a striking feature of the lobing is that the middle lobe is longer than those above and below it. The acorn which is often as long as 1 inch is ovoid in outline, and the nut is usually half enclosed by the woolly cup.

The wood of the post oak is resistant to rotting agencies when under ground and is much used for work of this nature, and in cooperage.

White Oak QUERCUS ALBA

From a commercial point of view this is probably the most valuable tree of the American continent. Its wide spreading branches and majestic trunk very actively suggest the idea of great architectural strength. The tree is frequently as high as 150 feet, but in the open usually shorter than this and correspondingly more widely spreading. It takes its name from the shallowly fissured light gray or whitish bark.

The deeply lobed leaf-blades are not bristle-tipped, and as in the post oak there is a tendency for the middle lobe to be longer than the lobes above and below it. The base of the blade is sharply wedge-shaped. When the leaves are about one third unfolded the flowers appear, followed in the same autumn by the usually stalkless acorns. The nut is ovoid or oblong and about ¾ of an inch long, covered only for its lower fourth by the woolly cup.

The tree is very common within its area of distribution, which extends from Quebec to Florida and westward. It is well represented in the Hudson Valley by many magnificent specimens.

American Elm ULMUS AMERICANA

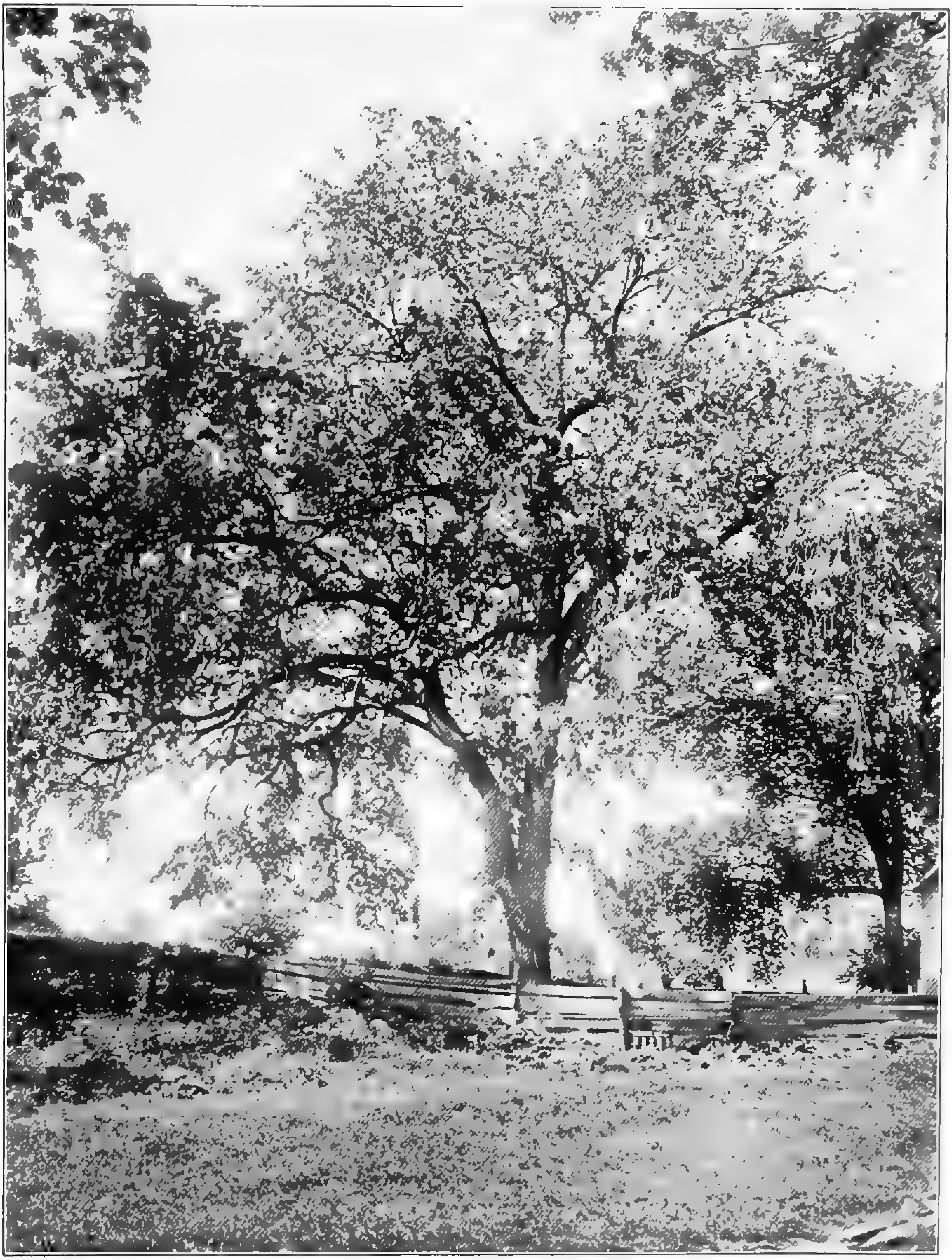
The American or white elm is the largest and most widely dispersed of our native elms. The well-known habit of branching gives the tree a distinctive and beautiful outline, which is particularly attractive in winter. The branches are without corky ridges, which distinguishes another native elm, and are usually reddish-brown. The leaf-blades are smoothish above, oval in outline, abruptly pointed at the apex, and from 2 to 5 inches long. The base of the blade is usually inequilateral, and the leaf margins are conspicuously toothed.

Some time before the leaves unfold the flowers appear. As the word is usually understood they are without petals. In early summer the little clusters of fruits mature. Individual fruits consist of a seed with a wing surrounding and closely investing it. In the American elm the seed-wing is smooth on its face but conspicuously hairy around its edges.

In New England the elm has been planted for decorative purposes more extensively than any other tree. It grows wild from Quebec to Florida and westward, and is very common in the Hudson Valley. Besides its decorative value the American elm is prized for its valuable wood which is much used for making ships, floors, and so forth. (Plate 142.)

Slippery Elm ULMUS FULVA

The highly mucilaginous inner bark of this tree has given it its common name of slippery elm. It is not so tall as



AMERICAN ELM

New Baltimore, Greene County, N. Y.

the American elm, and more local and rare in its distribution. The outer bark is darker and more deeply fissured.

In general outline the leaves much resemble those of the American elm but they are larger, more conspicuously toothed on the margins, and very prominently roughened on the upper surface. Its flowers are very similar to those of the better known tree but the fruits have one characteristic that is strikingly different from the preceding kind. The wing of the seed is quite smooth on its edges, and on the face it is hairy only immediately over the seed.

The slippery elm is found from Maine to Georgia and westward. It is fairly common along the Hudson, especially northward. The slippery elm lozenge is made from the precipitation of the mucilage which the tree secretes so extensively in its inner bark. The wood is also valuable for construction purposes.

Cork Elm ULMUS THOMASI

This is the least known and most locally distributed native elm. It attains a height of 80 or 90 feet in favorable situations. The trunk is stout, and clothed by the thick fissured bark. The lower branches are often conspicuously drooping, and the young branches have prominent corky wings along the sides.

The oval-outlined leaf-blades are sharp-pointed at the tip, and rounded at the nearly equilateral base. The marginal teeth are prominent, incurved and the large teeth are themselves toothed. Before the leaves unfold the flowers appear, followed in early summer by the fruits. These differ from both the American and slippery elm in having the seed-wing hairy on its margin and also its entire surface.

Railroad ties, bridges, and agricultural implements are all made from the wood of this tree. It grows wild from Quebec and Ontario to northern New York, Tennessee and westward. In the Hudson Valley it is rare, and only definitely known in the northern part.

The English elm (*Ulmus campestris*) is widely planted for ornament but is not known to have established itself as a wild element in our native flora.

Hackberry CELTIS OCCIDENTALIS

In the Hudson Valley this is not a common tree and frequently escapes notice as there it never attains its full dimensions; but further south and west it becomes 60 feet in height. The rough, often corky-winged bark is gray-brown and becomes scaly when old. The smooth leaf-blades are 2 to 4 inches long, oval in outline, with a fine-pointed tip, and a rounded or heart-shaped, inequilateral base. Sometimes there are marginal teeth and sometimes the margins are quite smooth. Just as the leaves unfold the small greenish flowers come out, usually at the base of a leaf-stalk. They subsequently develop into a fruit which is berry-like, but has a hard bony stone. The outside skin of the fruit may be red, or orange, but more frequently black.

In the Hudson Valley the hackberry is of little commercial importance as its scarcity precludes regular supply. Geographically the tree has a wide range, extending from the Atlantic coast to the Great Plains.

Rough-leaved Hackberry CELTIS CRASSIFOLIA

The rough-leaved hackberry is more rare than the common kind. Very few trees are known to occur in the Hudson Valley, but one good specimen occurs along the east bank of the river at the southern end of the Highlands. The tree may be distinguished from the common hackberry by its rough leaf-surface. In other respects it is closely related to the preceding species.

Red Mulberry MORUS RUBRA

This is the only native mulberry that grows in the Hudson Valley. The Old World white mulberry, so much grown for the silkworm industry, occurs only as an occasional escape from cultivation. The native species is a tree from 60 to 80 feet in height, with a trunk diameter of 3 to 4 feet. The long-fissured bark often splits off in plates.

For variety of leaf-shapes it is doubtful if many known trees equal the red mulberry. When young the leaves are often deeply lobed, sometimes one-sidedly so, and sometimes they are without lobes. The mature leaf-blade is usually oval in outline, with a square or heart-shaped base and an acute-tipped apex. The margins are prominently toothed. The catkin-clustered flowers come out with the leaves, the fertile clusters followed in early summer by the juicy fruits. These are really a conglomeration of many fruit-units all going to form what is popularly termed the fruit.

The wood has some commercial value, and the tree deserves wide planting for its decorative value. It is found from central New York to the Gulf of Mexico and westward. In the Hudson Valley it is local and rare in the southerly portion, and probably wanting northward.

Sweet Bay MAGNOLIA VIRGINIANA

In the southern states this often becomes a tree exceeding 50 feet in height, but in the Hudson Valley, it is not known to be more than a shrub or a shrub-like tree. On Staten Island and in adjacent New Jersey it grows in swamps.

The plant may be identified by its leathery lance-shaped or oval leaf-blades which are conspicuously white, silky-hairy, on the under side. Beautiful white, fragrant flowers appear in June and the conspicuous red fruits later in the summer.

Tulip Tree LIRIODENDRON TULIPIFERA

One of the most attractive trees for decorative planting in the eastern states is the tulip tree. Its giant columnar trunk is often free of branches for 50 or 60 feet but it may have branches lower than this in some specimens. The tree frequently exceeds 150 feet in height and is usually broadly oblong in outline.

The characteristic leaves give a striking distinctiveness to the tree. They are broadly heart-shaped at the base, and conspicuously notched at the apex; and the lobes are at first shallowly and subsequently deeply divided. The blade is shining and gives to the foliage its lustrous green color. In May or June the beautiful flowers appear. They are always solitary at the ends of young twigs, and their tulip-like form has given the tree its popular name. The orange-yellow or greenish-yellow color of the flowers is very conspicuous, and, as the flowers frequently exceed 1½ inches in depth, the tree is very attractive in full bloom. The cone-like fruits develop the same autumn and shed their seeds after the tree has become bare.

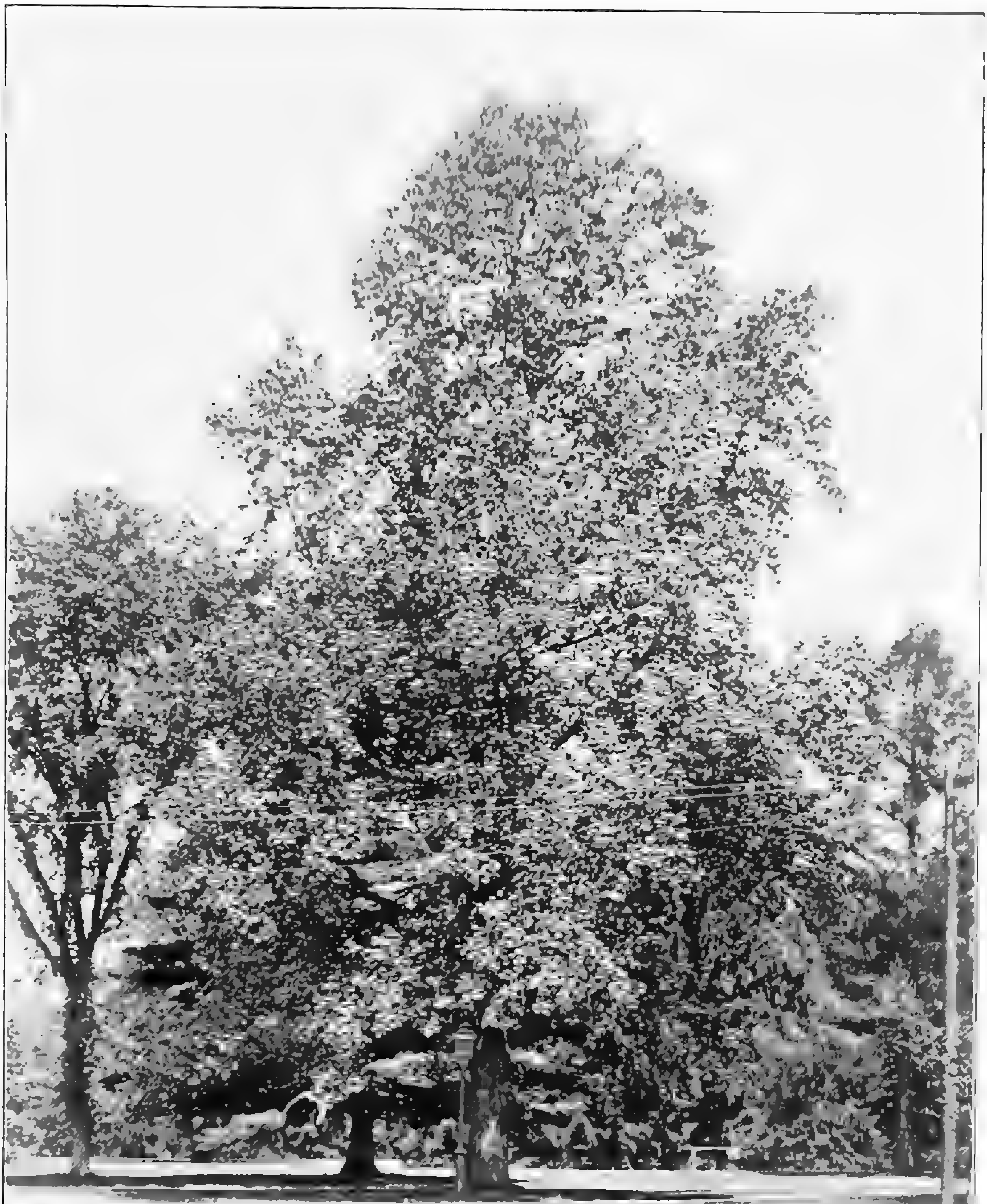
It is often known as the yellow poplar, saddle-leaf or white-wood, and under the latter name it is much used for carpentry. The native home of the tulip tree is from Massachuetts to Florida and westward. In the upper Hudson Valley it is rare and it is probable that most of the trees above Poughkeepsie are cultivated or derivatives of plants once cultivated. South of this point it is common. (Plate 143.)

Sassafras Tree SASSAFRAS SASSAFRAS

In central New York and Massachusetts which are the northern limits of the sassafras it is often a mere shrub but occasional trees are seen and they frequently exceed 30 to 40 feet in height. Further south the tree attains a height of 80 or 90 feet. Even on young trees the bark is very coarsely-fissured and brownish in color.

There is a bewildering variety of leaf shape on most sassafras trees. On the same twig one often finds unlobed oval-shaped leaf-blades, intermixed with leaves lobed on one or both sides. When fully mature they usually have two prominent lateral lobes and a terminal one. In all forms the base of the blade is more or less wedge-shaped. At the ends of the twigs, and appearing with or before the leaves, the yellow-green flowers are clustered. Each cluster is at first enclosed by a green bud. The fruits are almost round, more or less fleshy and scarcely more than ½ inch in diameter. They ripen in August or September.

Oil-of-sassafras is extracted from the roots and bark, and



TULIP TREE

Vassar College Campus, Poughkeepsie, N. Y.

medicinal properties are credited to the bark of the root and the pith of the twigs. The wood is used in making pails and buckets, and for fence posts. It is common along the Hudson but most of the specimens are more shrubby than treelike.

Sweet Gum LIQUIDAMBAR STYRACIFLUA

Of all the trees included in this list it is doubtful if one of them surpasses in brilliancy of coloring the gorgeous autumnal tints of the sweet gum. In the Hudson Valley it becomes a tree 100 feet high or more. Its branches are ascending, and when very young covered with dense brown hairs, which subsequently fall away.

The characteristic star-shaped leaf-blades have a conspicuous tuft of hairs at their base on the under side of the blade. The lobes of the leaf are all pointed and the terminal and two upper lobes are conspicuously larger than the lower lobes. Both the fertile and infertile flowers of the sweet gum are arranged in globular little heads. The infertile heads are clustered on slender stalks which are all joined to a main flower-stalk, while the fruit-producing flower-heads are solitary on a short stalk arising at the base of the infertile flower-stalks. The fruit matures in the autumn and is about 1½ inches in diameter; its whole surface is crowded with a collection of stout recurved prickles.

The wood of the sweet gum is used for a great variety of purposes, street paving-blocks being one of them. It grows naturally from Connecticut to Florida and westward. It is common in the lower Hudson Valley but rare or perhaps wanting north of the Highlands. (Plate 144.)

Button Wood PLATANUS OCCIDENTALIS

Peter Kalm, a discriminating historian and traveller, writing in 1749, relates that in the northern part of New York City, large groves of the button wood flourished. To-day it is a common tree throughout the Hudson Valley and is found very generally distributed in the eastern states.

The peeling of the outer bark and consequent exposure of large patches of the light gray inner bark is a conspicuous feature of this tree. The young branches, leaf-stalks and leaf-blades are all covered with a coating of white wool which falls off later. The broadly oval leaf-blades are coarsely-toothed or lobed, heart-shaped at the base, and sharp-pointed at the tip. Usually they are from 4 to 7 inches long, but vigorous young leaves are often twice this size. The little ball-like clusters of flowers have given the tree the frequently used name of button-ball. Usually the sterile and fertile flowers are arranged in separate flower-balls but sometimes a single ball may contain a mixture of both kinds of flowers. The fruit is scarcely more than 1 inch in diameter, ball-like, and yellow-brown in color.

The wood of the button wood, or sycamore as it is often called, is used for making tobacco boxes, ox-yokes and other articles and also for interior finishing. (Plate 145.)

American Mountain Ash SORBUS AMERICANA

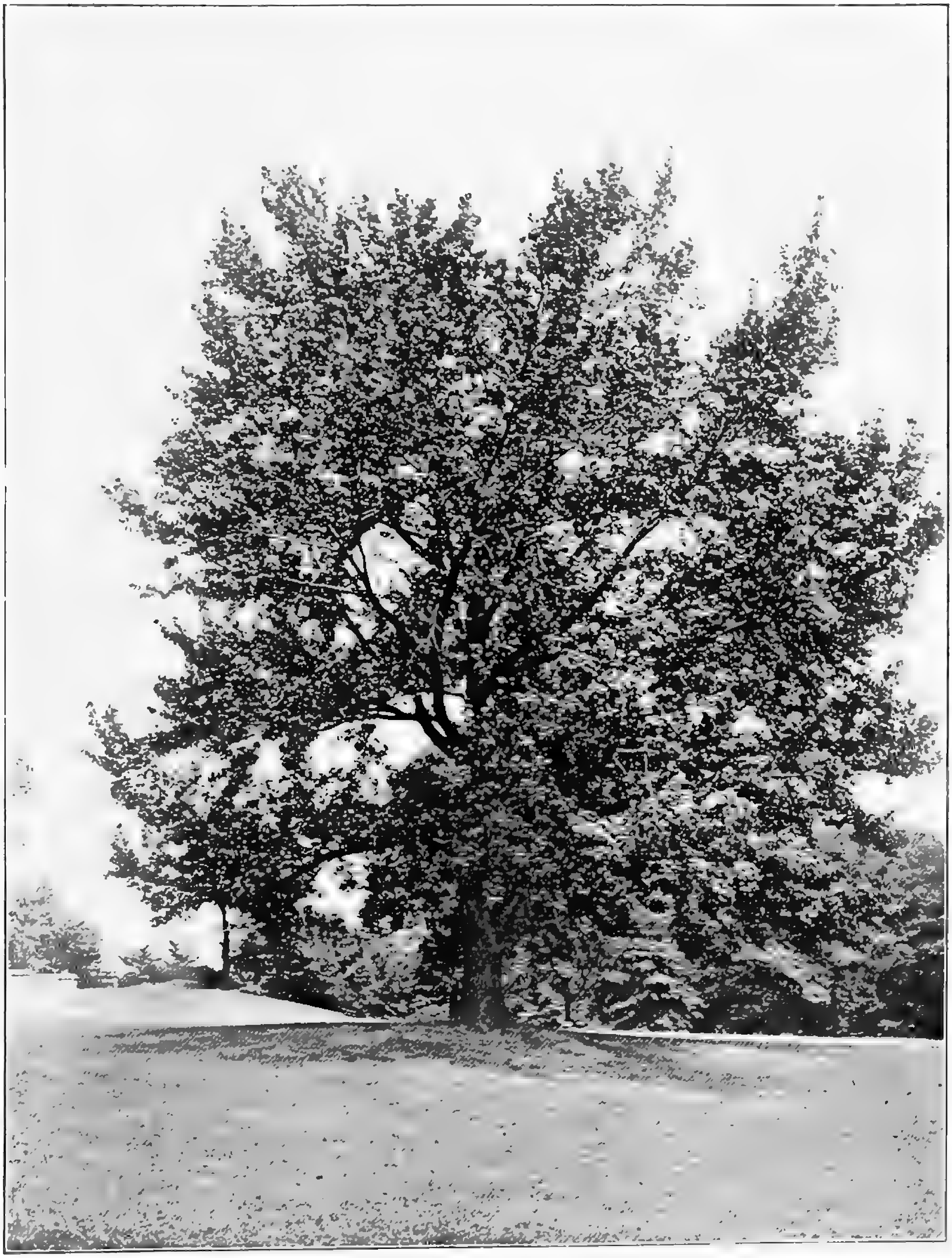
Throughout most of its range this plant is more shrub-like than tree-like, but in the far north it often attains a height of 25 feet.

The leaves are compound, that is, composed of from 12 to 18 lance-shaped leaflets all fastened to a common leaf-stalk. Each leaflet is acute at both ends and sharply toothed. The flowers are scarcely more than ⅛ inch in diameter but some hundreds of them are arranged in a broad flat-topped cluster that is frequently 3 or 4 inches across. In the fall the tree is conspicuous with its brilliant scarlet berries.

The tree is too small and weak-wooded in the Hudson Valley to be of any commercial importance, but its brilliant autumnal coloring and its clusters of white flowers make it a splendid tree for decorative planting.

American Crab Apple MALUS CORONARIA

The only native apple tree to grow wild in the Hudson Valley is this crab apple. All the ordinary apple trees are derived from the European apple, and in some places this



SWEET GUM

New York Botanical Garden

has escaped from cultivation and is now practically wild.

The crab apple is a tree sometimes as high as 25 feet, and its stout spreading branches often form a round-topped tree that is almost as wide as this. The oval-oblong leaf-blades are mostly rounded at the base and rounded or pointed at the tip. The marginal teeth are numerous and sharp. The flowers are usually clustered and make a magnificent showing in the early spring. The fine whitish or rose-colored petals, exhaling a delicate fragrance, are the most conspicuous feature of the flowers. In mid-summer the crab apples are ripe. They are usually about ½ inch in diameter, fragrant and greenish-yellow in color.

The natural range of the tree is from Ontario south to the District of Columbia and westward. It is evidently rare in the Hudson Valley but grows in northern New Jersey. A few tool handles and domestic articles are made from its wood.

Serviceberry AMELANCHIER CANADENSIS

The illustration gives a very fair idea of the shape of the serviceberry. The tree is seldom more than 40 feet high and often forms a symmetrical round crown. The shallowly fissured bark is dark reddish-brown and the twigs are the same color when old, and quite smooth. The leaf-stalks and young leaves are usually slightly hairy but become smooth when mature, except that the under side of the leaf-blades are sometimes persistently hairy. The leaf-blades are from 2½ to 4 inches long, oblong or oval-oblong in outline, and shallowly heart-shaped at the base. On the margins the leaves are somewhat coarsely toothed.

When the leaves are about one third grown the white flowers cover the tree. They are clustered and often the clusters droop. The fine white petals are arranged not unlike a star, and they are blunt at the tip and narrowed towards the middle of the flower. About July or August the reddish-purple fruits ripen. There are from 4 to 10 seeds in each fruit, which is not more than ⅝ inch in diameter.

Tool handles and machinery are sometimes made from the wood of the serviceberry and the fruit is often eaten. The tree grows wild from New Brunswick to Florida and is common in the Hudson Valley region. (Plate 146.)

Swamp Serviceberry AMELANCHIER INTERMEDIA

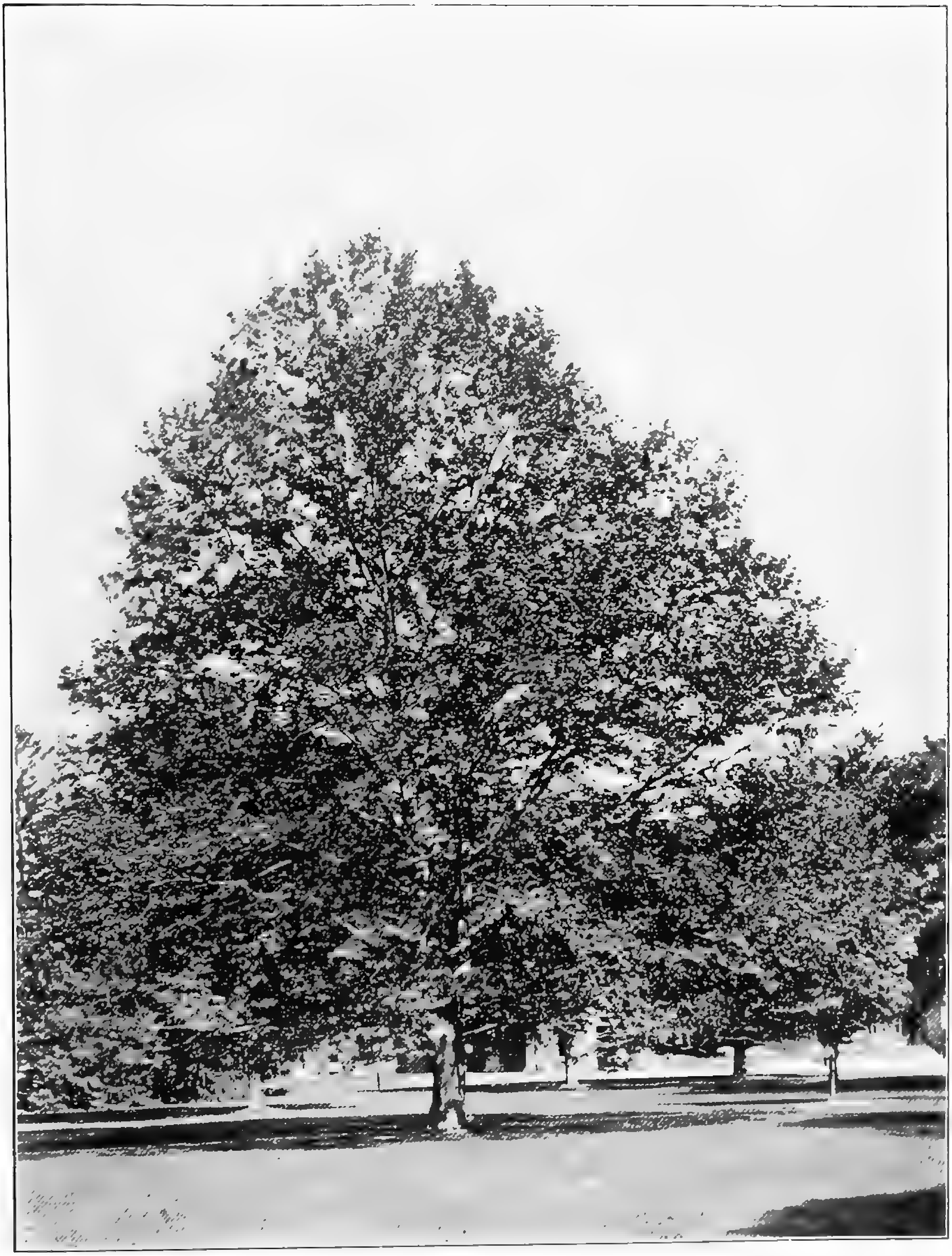
The swamp serviceberry is a smaller tree than the preceding and it has other distinguishing characteristics. It rarely forms such a symmetrical tree as the common serviceberry, and is usually spindly or scraggy when growing in a crowded forest; it may often be found with several trunks arising from the same point, and is more commonly a shrub than a tree.

When the leaves and twigs are very young they are covered with a growth of dense white wool, but most of this wool is shed as they grow older. In outline the leaf-blades are elliptic or oblong, and they are very rarely heart-shaped at the base. The margins are toothed except towards the lower end of the leaf-blade where the teeth are often wanting. Before the leaves are fully expanded the flowers come out. They are very similar to those of the common serviceberry. The fruits of this sort are somewhat larger than the preceding, and dark purple-black when ripe.

The swamp serviceberry is of little economic importance. It has a similar range to that of the serviceberry and is very common all along the Hudson.

Cock-spur Thorn CRATAEGUS CRUS-GALLI

Most of the thorns are mere shrubs but a few are small trees. They are armed with curved or straight prickles. The cock-spur thorn is often a tree 20 feet high or more with smooth, spreading branches. The leaf-blades are elliptic or sometimes wider above the middle, dark green and leathery when old. The leaf-margins are conspicuously toothed at the apex but smooth at the base. In early summer the tree is covered with a profusion of white flowers. These are usually arranged in little clusters of 7 or 8. In



BUTTONWOOD

Vassar College Campus, Poughkeepsie, N. Y.

the fall the dull red apple-like fruits make the tree very attractive. These miniature apples are about ½ inch in diameter and contain usually only 2 stones, imbedded in the greenish flesh.

The tree is of little economic importance except for decorative planting. It is found wild from Lake Champlain to Georgia and westward. It is common in the lower and central Hudson Valley.

The English Hawthorn (*Crataegus Oxyacantha*) is botanically related to the cock-spur thorn and may be distinguished by its jagged leaves, and its usually single stone imbedded in the yellow flesh. It is known in the Hudson Valley only as an escape from cultivation.

Large-fruited Thorn CRATAEGUS PUNCTATA

The shallower double-toothing of the leaf-margins of this thorn is very distinct from the toothing of the leaves of the cock-spur thorn. The fruits are brick-red and almost always contain 3 or 4 stones, imbedded in the greenish-yellow flesh. The tree attains a height of 25 feet or more.

It grows from Quebec southward to Georgia and is fairly common along the Hudson Valley.

The waxy thorn (*Crataegus pruinosa*) is not a very large tree and is found growing from the Thousand Islands to the southern Appalachians. From the preceding sorts it can be distinguished by its leaf-blades which are broadest towards the base. The fruit is waxy and purple-green in color. It is common in the area covered by this list.

Round-leaved Thorn CRATAEGUS ROTUNDIFOLIA

This is credited with a distribution further north than any other North American thorn. It is also widespread, growing as far south as Virginia and westward to Wisconsin.

It frequently attains a height of 20 feet and forms a beautiful round-topped tree. The dark red-brown bark is scaly on the trunk but smooth on the twigs. The prickles are from 1 to 3 inches long and usually curved. The leaf-blades are oval and roundish in outline and lobed or coarsely double-toothed on the margins. In late spring the beautiful clusters of white flowers make the tree very attractive. About October the dark red fruits ripen, and they are usually about ½ inch in diameter and almost round. Imbedded in the dry yellow flesh are usually 2 to 4 stones.

Thin-leaved Thorn CRATAEGUS TENUIFOLIA

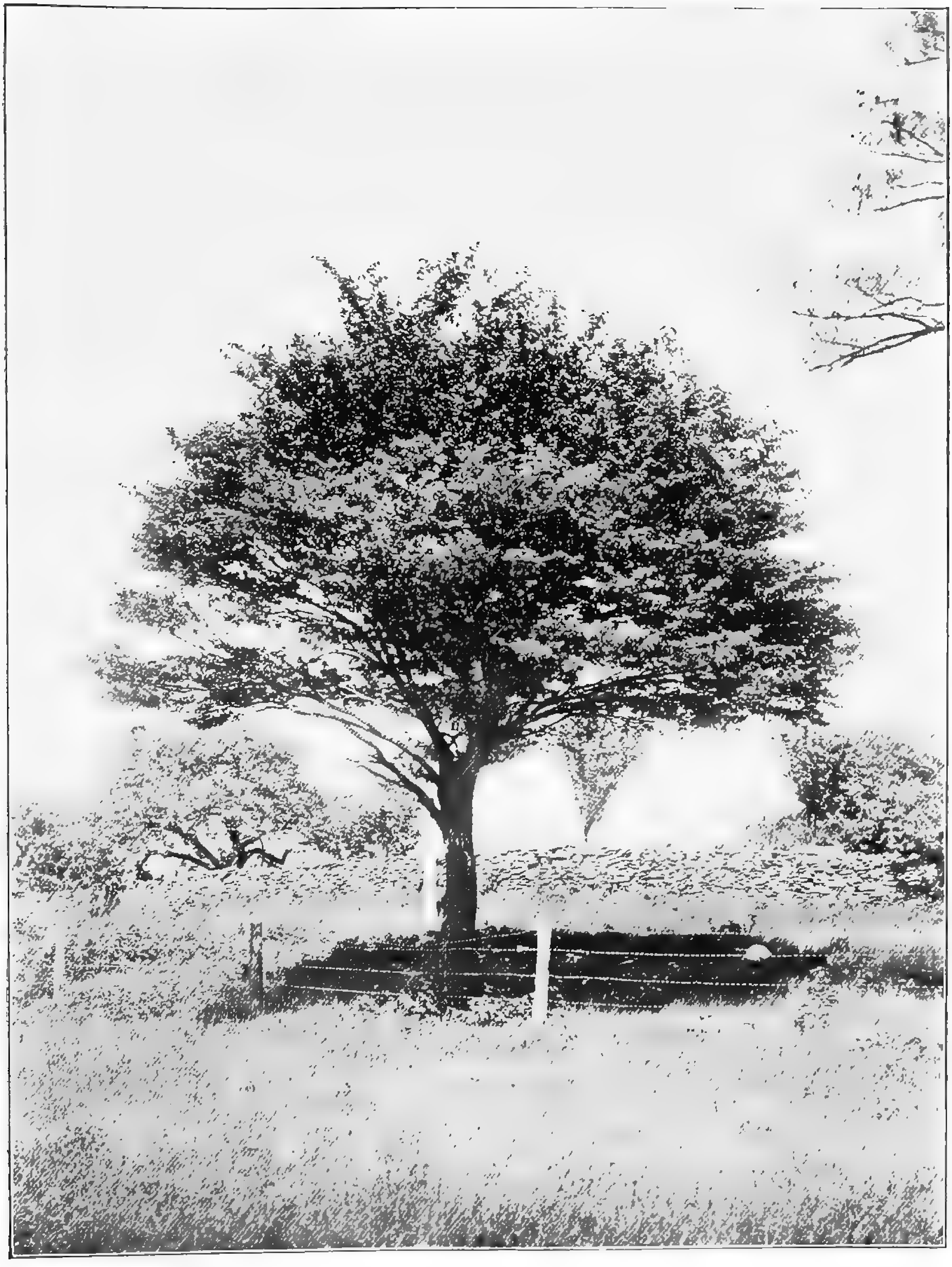
In early spring this thorn is a conspicuous feature in the landscape as its young leaves are bronze-red. The tree is often 25 feet high or more, and usually has a large round crown. On the trunk the bark is scaly and gray-brown but the twigs are smooth and reddish-brown. The ellipsoid or oval leaf-blades are coarsely double-toothed on the margin, green on the upper surface and somewhat paler on the lower. The leaves have a tendency to be broadest towards their bases. The many-blossomed clusters of flowers are attractive in the early summer, followed in August or September by the small apple-like fruits. These are crimson, pear-shaped or oblong and not more than ¾ of an inch in diameter. In the acid yellow flesh there are usually 4, sometimes 3 or 5, stones imbedded.

The thin-leaved thorn grows wild from western New England to Virginia and westward. It is fairly common in the upper and central part of the Hudson Valley.

The twin-mountain thorn (*Crataegus pentandra*) differs from the thin-leaved thorn in having mostly 3 stones imbedded in the flesh of the fruit. It rarely exceeds 15 feet in height. It is known to grow in the central part of the Hudson Valley.

Pringle's Thorn CRATAEGUS PRINGLEI

This is one of the most variable thorns of the region. The lobing of the leaves is often very different on separate plants but usually the leaf-blades are coarsely double-toothed or lobed. The many-flowered clusters of blossoms are very beautiful in the early summer and the fruit matures later



SERVICEBERRY

New Baltimore, Greene County, N. Y.

than that of most of the thorns. It is red, hairy, and is often eaten, but is too acid to be generally liked.

In Dutchess County Pringle's thorn is common but north and south of this it is apparently rare in the valley.

Red-fruited Thorn CRATAEGUS MOLLIS

This well-known thorn is often called the red haw. It grows from Quebec to Tennessee and westward and is common along the Hudson Valley. It often attains a height of 35 feet and forms a broad round-topped tree.

The broadly oval leaves are sharply and deeply toothed, cut square or heart-shaped at the base and sharp-pointed at the tip. On the upper surface the leaf-blades are finely hairy, and on the lower surface woolly hairy. The curved prickles are not more than 2½ inches long. After the flowers, which form many-blossomed clusters, mature, the fruits ripen. The latter are usually ripe by September, and have a yellow acid flesh. The outside of the fruit is crimson. There are commonly 5 stones imbedded in the flesh but occasional fruits are found with only 4 stones.

Brainerd's Thorn CRATAEGUS BRAINERDI

So far as the Hudson Valley is concerned this is a localized plant. In the region about Dutchess County it is common, but beyond this it is rare. However it grows freely in western New England and is common in Pennsylvania. From all the preceding thorns it may be distinguished by its fruits. Those previously mentioned have the stones of their fruits without pits, but this sort has its fruit-stones pitted. Individual stones may sometimes be found lacking this characteristic but most of them are at least shallowly pitted.

Long-spined Thorn CRATAEGUS MACRACANTHA

This is a common and widely dispersed plant. It seldom attains a height of more than 25 feet and forms an irregular, broad head. Its long, curved prickles, frequently exceeding 4 inches, gives the tree its common and technical names.

In outline the leaf-blades are oval, sharp-pointed at the base and similarly shaped at the tip. The lower quarter of the leaf-margin is mostly quite smooth, but from this point upwards the margins are conspicuously but finely double-toothed. Towards the tip the teeth often give way to distinct lobes. The many-flowered clusters of blossoms make the tree very attractive for planting. These are followed by the fruits which ripen about September. In outline the fruits are almost perfectly round. Imbedded in the sweet, pulpy, yellow flesh are 2 or 3 stones that are conspicuously and deeply pitted.

Wild Yellow Plum PRUNUS AMERICANA

A tree sometimes reaching a height of 35 feet. The numerous branches are wide spreading and armed with prickly spurs. On the trunk the bark is split up into dark brown plates and on the branches it is reddish and smoother. The elliptic-oval leaves are from 2 to 5 inches long, rounded at the base and rather sharp-pointed at the tip. The leaf-margins are finely but sharply toothed. On the upper side the leaf-blade is dark green and smooth while the lower surface is paler and hairy, at least on the nerves or veins.

In May the tree is covered with the profusion of white flowers that has occasioned its popularity for decorative planting. The fruit follows, maturing about the middle of September. It is not quite round, about 1 inch in diameter and orange or bright red in color. The acid, yellow flesh is not much used, except for preserving, and imbedded in it is the oval, flattened stone.

The tree grows naturally from New York to Florida and westward. In the Hudson Valley it is more common towards the southern end than northward. Beyond its decorative value and the use of the fruits for preserves, the wild yellow plum is of little economic importance.

The common garden plum (*Prunus domestica*) grows wild in the Hudson Valley only as an escape from cultivation. The flowers appear in April or May with the leaves and its well-known fruit is too familiar to need description.

Wild Red Cherry PRUNUS PENNSYLVANICA

If the wild red cherry were a longer-lived tree it would be splendid for decorative planting. Its profusion of early bloom and the great number of bright red fruits make it exceedingly attractive. In favorable places it attains a hieght of 30 feet and a trunk diameter of 10 inches. The oblong or lance-shaped leaf-blades are from 3½ to 5 inches long, and finely, but doubly, toothed on the margins. In April or May the tree is a riotous mass of bloom, the flowers being arranged several in a cluster. The 5 petals are somewhat broader upward than toward the center of the flower. The round fruits are smooth and bright red, being much eaten by birds, although the flesh is bitter and rather thin. Imbedded in it is the round and slightly rigid stone.

On account of its soft wood the wild red cherry is little used except for fuel. It grows from Newfoundland to Georgia and westward, and is common along the Hudson, particularly northward.

The common sweet cherry (*Prunus Avium*) is often found growing wild in the eastern states, presumably spread by birds. The plant is a native of Europe.

Wild Cherry PADUS SEROTINA

The arrangement of the flowers of the wild cherry and the choke cherry is very different from those of the other cherries and plums. Those previously mentioned all have their flowers arranged in clusters with the individual flower-stalks arising several in a bunch. In the wild and choke cherry there is a general flower-stalk, rather long, and attached to this are numerous small individual flower-stalks. The flower cluster is thus oblong and contains from 30 to 40 flowers or even more.

The wild cherry is often 80 feet in height with a trunk covered wtih dark red-brown bark. The oblong-oval leaves are from 2 to 5 inches long and taper-pointed at the tip. Along the margins the leaf-blade is toothed and the teeth are distinctly incurved. The white flowers cover the tree in May or June, followed later by a drooping cluster of fruits. These are purple-black when ripe, about 1/3 to 1/2 inch in diameter, and with an astringent flesh in which is imbedded the oblong, pointed stone.

Alcoholic liquors are sometimes flavored with the fruits of the wild cherry, which are also used for preserving. The tree is common from Nova Scotia to Florida and westward, and is plentiful throughout the Hudson Valley.

Choke Cherry PADUS VIRGINIANA

The choke cherry is similar to the wild cherry, but usually smaller. In our region it rarely develops a trunk but occasional trees may be found. They never exceed 25 feet. From the flowers of the wild cherry they have practically no distinguishing characters, but the fruit is smaller and reddish instead of black-purple. The teeth of the leaf-margins are not incurved as those of the wild cherry, but spreading. Without seeing either flower or fruit the trees may be distinguished by this character of the marginal teeth of the leaves.

As a shrub the plant flourishes over a large part of the continent but as a tree it is rare. It is common in the Hudson Valley, particularly along roadsides, where its white clusters of flowers make it very attractive in the spring.

Honey Locust GLEDITSIA TRIACANTHOS

This often forms a magnificent spreading tree that exceeds 120 feet in height. Its trunk, which is commonly 2 to 4 feet in diameter, is covered with a coarse, brown bark. The zigzag twigs are often armed with stout branching prickles that frequently exceed 4 inches in length. The leaves are doubly compound; that is, there is one main leaf-stalk to which are attached from 4 to 18 pairs of secondary leaf-stalks and these minor stalks usually have from 7 to 10 pairs of leaflets attached to them. All the leaf-stalks are hairy. The leaflets are ovate or elliptic, short-stalked, and not more than 1 1/2 inches long. They often " fall asleep " at night, when they will be found face to face, instead of spread apart. Both sterile and fertile flowers are found on the honey locust, and they are both somewhat irregularly unequal, arranged in finger-shaped clusters and greenish in color. They contain great quantities of nectar and are much visited by bees. The subsequent fruits are pea-like but much longer than ordinary garden peas, frequently exceeding a foot in length. The seeds are flat and oval.

The durability of the wood of the honey locust when underground has made the tree much prized for fence posts and railroad ties. It grows wild from Ontario to Pennsylvania and Florida; most of the trees in the Hudson Valley are presumably naturalized as it seems not to have been ancestrally wild in the valley. To-day it is common.

The locust (*Robinia Pseudacacia*) is not a wild tree in the Hudson Valley but has become naturalized from its frequent cultivation. Its trunk is covered with deeply-fissured bark, and often forks into several main branches. The flowers are in clusters, white, and are much like a common pea. The pods are quite smooth. Naturally the tree is confined to a narrow belt stretching from southern Pennsylvania to Georgia. Its wood is very hard and durable.

The clammy locust (*Robinia viscosa*) may be distinguished from the preceding by its smaller stature, red or pinkish flowers, and hairy pods. Its natural range is confined to a small area in Tennessee and North Carolina; the many wild trees in the Hudson Valley are escapes from cultivation.

Staghorn Sumach RHUS HIRTA

Most of the sumacs are shrubs, but an occasional tree 30 feet high may be found. The bark on the trunk and larger branches is smooth and brown; very rarely it splits up into small plates.

The compound leaves are from 16 inches to 2 feet long, hairy, and composed of from 11 to 31 leaflets, all attached to the common, reddish, or greenish-red leaf-stalk. The leaflets are themselves practically stalkless, lance-shaped or oblong and sharp-pointed at the tip. The margins are finely toothed. There are two kinds of flowers, fertile and sterile, and they are usually found on separate trees, but occational trees have both kinds on the same plant. Both kinds of flowers grow in large clusters, and the fertile flowers bloom about ten days later than the sterile. The fruits are in dense clusters, and when ripe the fruit-cluster is covered with a quantity of dark red hairs, thus giving the plant a beautiful color scheme in the early fall and late summer.

This sumac is common throughout the eastern states. The wood is of little value, but the bark and leaves are rich in tannin.

The scarlet sumac (*Rhus glabra*), a closely allied plant, is smaller than the staghorn sumac and it may be distinguished by its perfectly smooth leaves which are conspicuously whitish on the under side. It, too, is very common, as a shrub, but it rarely becomes a tree in the Hudson Valley.

American Holly ILEX OPACA

It is only in the extreme southern part of the Hudson Valley that we find the holly. On Staten Island and Sandy Hook the tree was formerly abundant. In favorable situations it reaches a height of 50 feet and a trunk diameter of 2 feet.

Its well-known, prickly-margined leaves are from 2 to 5 inches long, quite stiff and leathery. There are two kinds of flowers on the holly, fertile and infertile and they are almost never found on the same trees. Both kinds are white and rather inconspicuous. It is mostly from the fertile trees that the Christmas sprays are picked with their profusion of bright red berries. Inside the berries there is a small prominently ribbed stone.

The whiteness and compactness of its wood make the holly desirable for turnery and it is also used in cabinet work and interior finishing. The tree is a slow grower.

Striped Maple ACER PENNSYLVANICUM

Most of our native maples are large trees, at least 50 feet high or more; but the striped maple and the mountain maple are more frequently shrubby than tree-like. So far as the Hudson Valley is concerned these two kinds, and one other, differentiate themselves, also, from all the other maples by the arrangement of their flowers. In the tall growing kinds there are several flower-stalks that arise at one point, so that there is no real flower-cluster; only several individually stalked flowers. In the striped and mountain maples there is a rather long common flower-stalk which bears numerous stalklets that support the flowers. The whole flower-cluster is often 4 or even 6 inches long.

The striped maple takes its name from the striping of its young bark. It is prominently marked by white or greenish-white stripes, but these become fainter on the old wood. The broad 3-lobed leaves are often 5 inches long, heart-shaped at the base and usually yellowish-green on the upper surface. From the mountain maple it can readily be distinguished by its drooping flower-clusters.

The plant occurs mostly as a shrub within the Hudson Valley, but a few good-sized trees are found in the Catskills and farther north it attains a height of from 30 to 40 feet. South of Kingston it is rare in the Hudson Valley.

Mountain Maple ACER SPICATUM

Of the eastern North American maples this species is the smallest. It is usually shrubby and in the Hudson Valley it is doubtful if it attains a greater height than 25 feet. It is a shade-loving plant and in favorable places it is exceedingly common. The leaves are from 3½ to 4½ inches long and either 3-lobed or partially 5-lobed. The margins of the lobes are coarsely toothed. The comparatively stiff and erect flower-cluster is a prominent feature of the mountain maple and this character serves as a ready distinction between it and the preceding kind. The fruits, as in all maples, are two-winged, to the imaginative suggesting an old time key. In the mountain maple they are reddish and the wings are not spreading while in the striped maple the wings are widely spreading and bright green.

The mountain maple is common from northern New York to Georgia and westward. In the Hudson Valley it is very common from the Highlands northward. It is too small to be of economic importance.

Silver Maple ACER SACCHARINUM

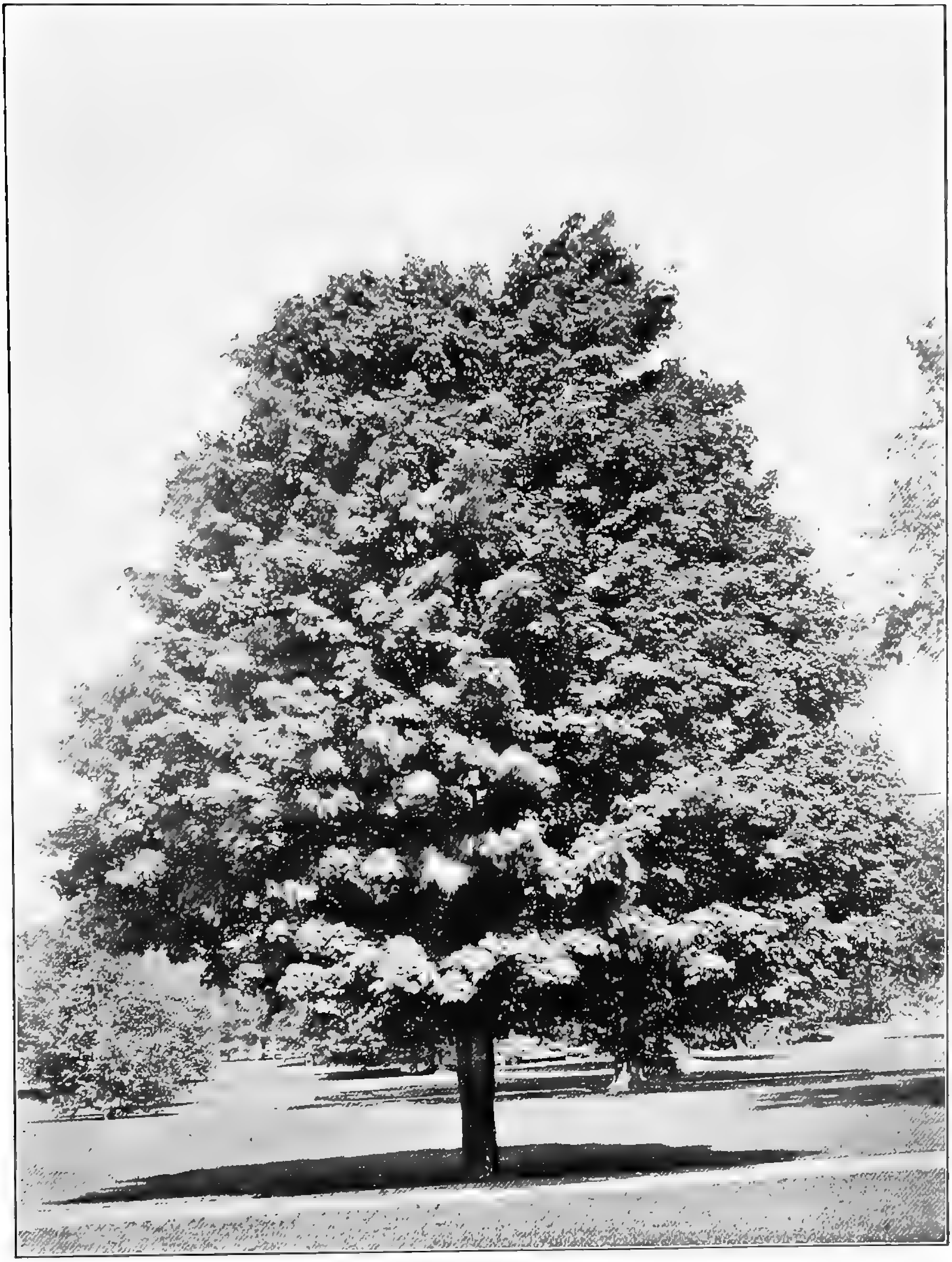
This is one of the most beautiful and widely planted maples used for ornamental purposes. It frequently attains a height of 120 feet and a trunk diameter of 3 feet. On the old trunks the bark is split into thin scales but the young branches are clothed with a smooth bark.

The leaf-blade is roundish in general outline, but is deeply 5-lobed to beyond the middle. They are bright green on the upper side, whitish or gray beneath. Long before the leaves appear the tree is covered with its flowers. They are greenish-red, but have no petals. Each individual flower-stalk is so short that the flowers appear to be stalkless and attached several together along the sides of the twigs. The typical " key " fruits have widely diverging wings.

The silver maple grows plentifully from New Brunswick to Florida and westward. It is common throughout the Hudson Valley. The brittleness of its wood has limited its use in the arts and manufactures.

Red Maple ACER RUBRUM

The natural home of the red maple is in swamp lands, and often in the spring, before the foliage appears, the brilliant red flowers give a characteristic ruddy tinge to many of our swamps. The tree is often 120 feet in height and with a trunk 3 feet in diameter. On the old branches and trunk the bark splits off in rough plates; the younger branches are smooth-barked. The 3- or 5-lobed leaves are from 2 to 6 inches long and the lobes are more or less sharp-pointed. The silver maple and the red maple are the only tall kinds



SUGAR MAPLE

Vassar College Campus, Poughkeepsie, N. Y.

that flower before the leaves develop, and from the former the red maple may be distinguished by its stalked flowers. The fruits are also red, and the foliage turns bright red in the autumn, so the tree is well-named.

Throughout the eastern states the tree is common and in the Hudson Valley it may be found in great quantity. Its wood is largely used in the manufacture of furniture. Scarlet maple and swamp maple are names often used for this tree.

Sugar Maple ACER SACCHARUM

Maple sugar and maple syrup have made this the most widely known of all our native maples. It rarely exceeds 120 feet in height, and when perfectly developed it has a great dome-like crown. The brown channelled bark of the old trunk does not split off in plates. The leaf-blades are roundish in outline, 3- or 5-lobed and sometimes as wide as 6 inches across the broadest part. On the upper surface they are dark green, on the lower paler or even bluish-green. Unlike the two preceding kinds the flowers of the sugar maple do not come out until the foliage is well developed. They are greenish-yellow and very conspicuous. The wings of the " key " fruits are almost parallel and strongly veined.

The tree is confined to the region east of the Mississippi and its tributaries, and is common in the Hudson Valley particularly northward. The wood is valuable for decorative finishing of all kinds, and the tree may be annually tapped for its sap, from which maple syrup and sugar are made. From 12 to 13 quarts a year per tree is an average yield of syrup. (Plate 147.)

Black Maple ACER NIGRUM

In some localities this tree seems to usurp the place of the sugar maple, to which it is very closely allied. In the Hudson Valley the black maple is rare and local. It frequently attains the same stature as the sugar maple and its flowers and fruits are very similar to those of the better known tree.

The wings of the " key " fruit of the black maple are scarcely parallel, tending, rather, to diverge when old. The most distinctive difference between the two trees is the leaves. In the sugar maple the under-side of the leaf-blades is paler than the upper; in the black maple the leaf is uniformly green throughout.

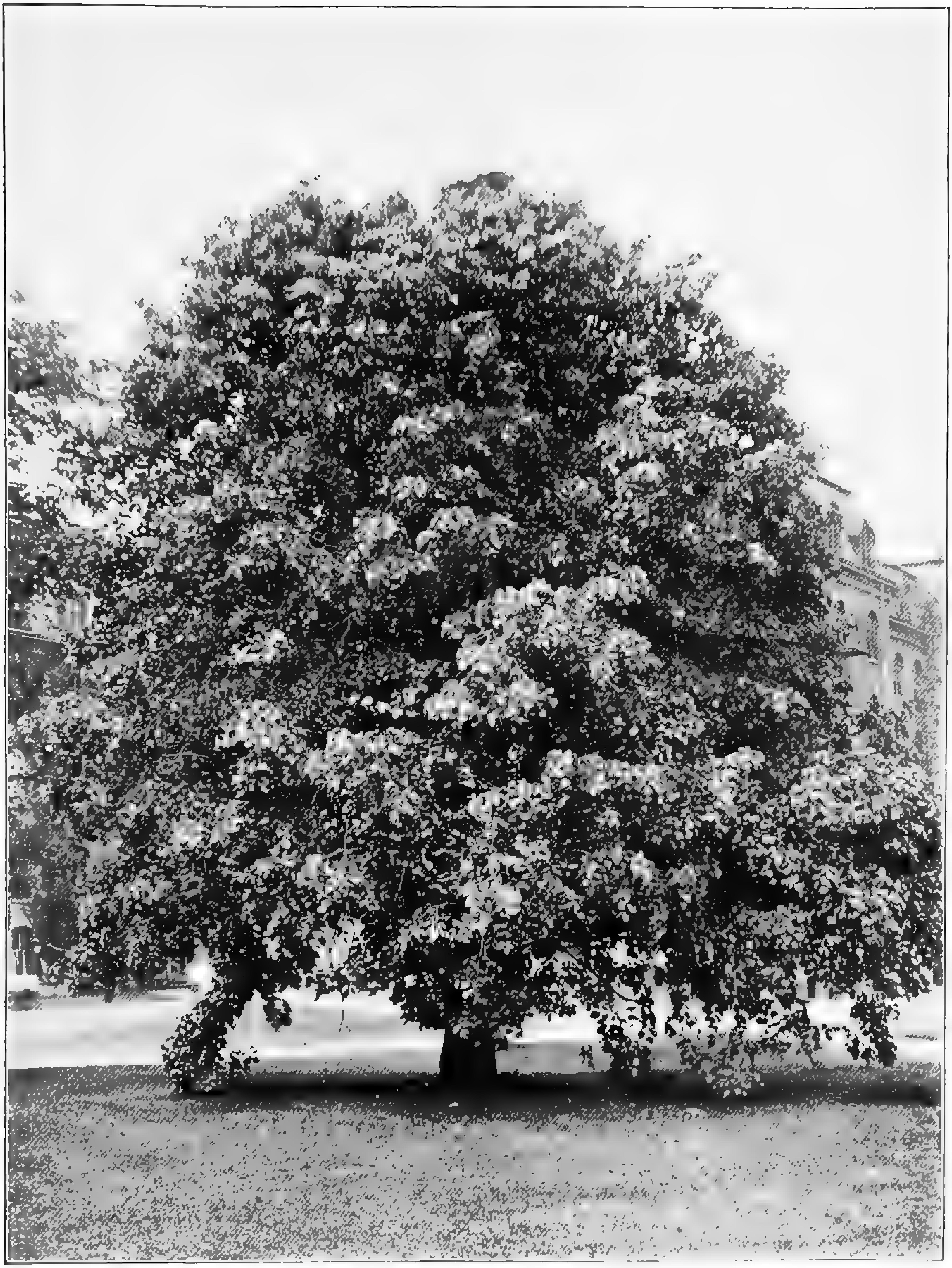
The black maple grows from Quebec to Georgia and westward. Its wood is used for the same purpose as that of the preceding, and a little sugar is made from its juice.

The Norway maple (*Acer platanoides*) is our most widely planted foreign maple. In the Hudson Valley it occurs wild only as a very rare escape from street or garden plantations. It is a native of northern Europe.

Ash-leaved Maple ACER NEGUNDO

This tree takes its common name from its compound leaves which are somewhat like those of the ash. In the Hudson Valley it is the only maple that has a leaf composed of from 3 to 5 leaflets all joined to a common leaf-stalk. The tree often attains a height of 50 feet or more and the trunk is clothed with a thick-ridged and scaly brown bark. The leaflets, one or two parts of which with a terminal one are attached to a common leaf-stalk, are thin, oval or lance-shaped, and often irregularly or one-sidedly lobed. Either with the leaves or a trifle before them, the bright green flowers bloom. The flowers are without petals, and arranged in clusters similar to those of the striped maple and rock maple. When the tree is in fruit the cluster elongates greatly. The wings of the " key " fruits are divergent at various angles.

The ash-leaved maple grows from New York along the mountains to Alabama and westward. As a wild plant it is not definitely known in the Hudson Valley but it may be found in the northern part and it is much planted for ornament. The wood is soft and weak and is used to a limited extent in the manufactures. Paper pulp is made from it.



AMERICAN LINDEN

Vassar College Campus, Poughkeepsie, N. Y.

American Linden TILIA AMERICANA

When growing in the open the linden is apt to develop into a broad round-topped tree, but in the forest it is taller and more slender, often attaining height of 110 feet and a trunk diameter of 3 feet. The old bark is dark gray and furrowed into flat ridges. In outline the leaf-blades are oval or roundish, sharp-pointed at the tip and more or less unequally heart-shaped at the base. The blade is from 5 to 8 inches long and about ⅔ as wide.

The stalk of the flower-clusters in the linden tree are peculiar, and make it comparatively easy to distinguish it from all the other trees of the Hudson Valley. To the lower third or half of the flower-stalk is fastened a leaf-like organ which is from 5 to 8 inches long and about ⅕ as wide. These leaf-like flower-bearing organs occur indiscriminately mixed with the true leaves. There are from 5 to 20 flowers in a cluster, and they subsequently develop into the ovoid fruit containing a good sized seed.

The tree grows naturally from New Brunswick to Georgia and westward. It is common all along the Hudson. The soft wood is largely used for furniture, carriages, and woodenware; it is also a productive source of wood-pulp for paper manufacture. (Plate 148.)

Hercules Club ARALIA SPINOSA

In the south this plant often becomes a tree 25 feet or more in height. Towards its northernmost limit it becomes increasingly scarce. A few small trees have been found in the extreme southern part of the Hudson Valley, which may, however, have escaped from cultivation. All the woody parts of the plant are covered with short stout prickles. There is some popular misunderstanding of the leaves of the Hercules club. The leaf is very large and composed of a great many leaflets, which are attached to leaf-stalks that are themselves joined to the main or central leaf-stalk. The whole leaf is from 2 to 4 feet long; the leaflets scarcely more than 3 or 4 inches long, oval, thick and sharp-pointed. The midrib on the under-side of the leaflets is often prickly. There is a huge flower-cluster sometimes 4 feet long, composed of hundreds of tiny white flowers. The fruits are black.

The tree is valuable for its decorative effect, but the wood is soft and weak.

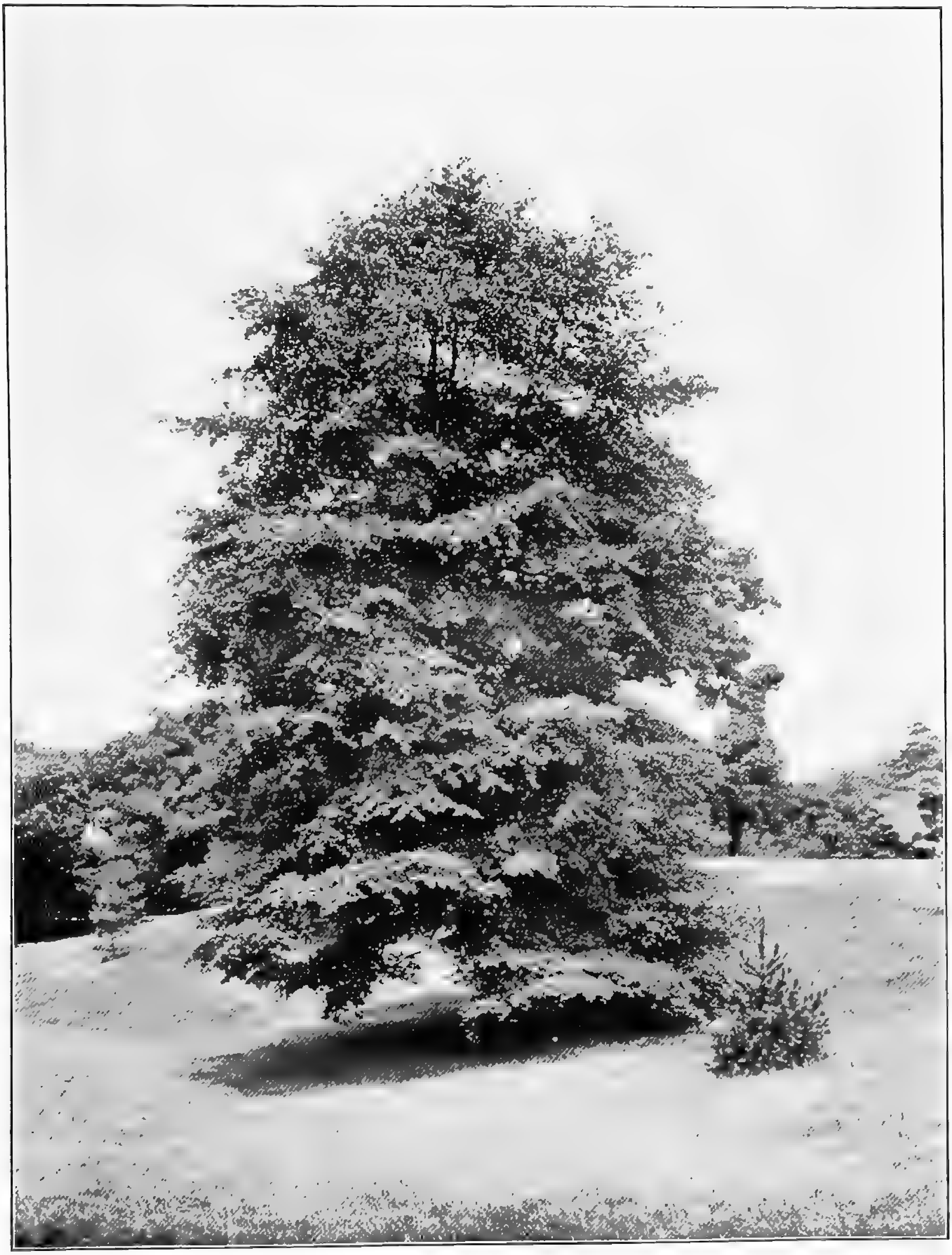
Sour Gum NYSSA SYLVATICA

This tree is often known as tupelo and pepperidge, and loves moist swampy places. It grows commonly in such situations from Maine to Florida and westward and under favorable conditions it attains a height of 140 feet. The branches are widely spreading and often the lower branches are conspicuously drooping. The leaves which turn brilliant crimson in the autumn, are more or less oval in outline, but usually broadest above the middle. They are taper-pointed at the tip, roundish at the base, and from 2½ to 6 inches long. There are two kinds of flowers which appear about May. The sterile flowers are arranged in many-blossomed clusters, the fertile or fruit-producing in clusters of 3. The dark blue or purple fruits, usually arranged in clusters of 3, are about ½ inch in diameter and contain a many-ribbed stone.

The wood of the sour gum is soft, but very tough and hard to split. For this reason it is much used in making wheels, rollers and ox-yokes. The sour gum requires a moist situation for favorable development, and if such a place can be found for it the tree is well worth planting for decorative effect. (Plate 149.)

Flowering Dogwood CYNOXYLON FLORIDUM

This tree scarcely ever exceeds 40 feet in height, but it is one of the most showy and popular trees of the eastern states. The old bark is dark brown or nearly black in color, and is split up into small scales or plates. The leaf-blades are oval or elliptic in outline, and more or less sharp-pointed at both ends. The leaf-margins are shallowly toothed or quite smooth.



SOUR GUM

New York Botanical Garden

In early spring the tree is covered with what appear to be large white flowers. There are 4 of these petal-like leaves, each one notched at the tip, and they are really nothing more than a sheath which covers the small greenish flowers. These may be found at the point where the large white, petal-like leaves converge, and after the latter have withered the true flowers bloom. They are followed later by the bright red fruits which contain a hard stone.

Owing to its showy whiteness in the spring and the beauty of its branching the dogwood is much planted in lawns and parks. It grows wild from Massachusetts and Ontario to Florida and west; and is very common throughout the Hudson Valley. Its wood is much used in making parts of machinery, and tool-handles.

Persimmon DIOSPYROS VIRGINIANA

It is only in the southern part of the Hudson Valley that we find the persimmon. Its range of distribution is from Rhode Island to Florida and westward, and it is only near Long Island Sound, on Staten Island and adjacent New Jersey that the tree is known to occur with us. Here they are scarce and local. In the north the tree is never more than 40 to 50 feet in height, but southward it becomes twice this size. The thick bark is dark brown or almost black, and somewhat irregularly fissured. When very young the leaves are hairy but they are quite smooth in age. In outline they are oval or oblong and from 3 to 7 inches long, sharp-pointed at the tip and more or less rounded at the base. There are two sorts of flowers, appearing about May or June. The fertile are solitary and the infertile are arranged in little clusters; both are greenish in color. The fruit is orange or reddish-orange in color, about an inch in diameter, and often persists late into the winter. The wood is used for the manufacture of shoe-lasts.

Black Ash FRAXINUS NIGRA

When growing in its favorite habitat the black ash attains a height of 90 feet and a trunk diameter of 20 inches, but most of the trees in the Hudson Valley are smaller than this. The thin, scaly bark is gray in color, and slightly fissured. The compound leaves are from 10 to 16 inches long and are composed of from 7 to 11 leaflets. The latter are practically without stalks and this characteristic is peculiar to this ash, all the other Hudson Valley ashes having stalked leaflets. The flowers are borne in many-flowered clusters. The individual flowers are without petals or covering of any kind. The fruits are clustered and each one is surrounded by a wing, the upper end of which is notched.

The wood of the black ash is very durable underground and it is much used for fence posts. It is also used in basket-making, interior finishing and cabinet-work.

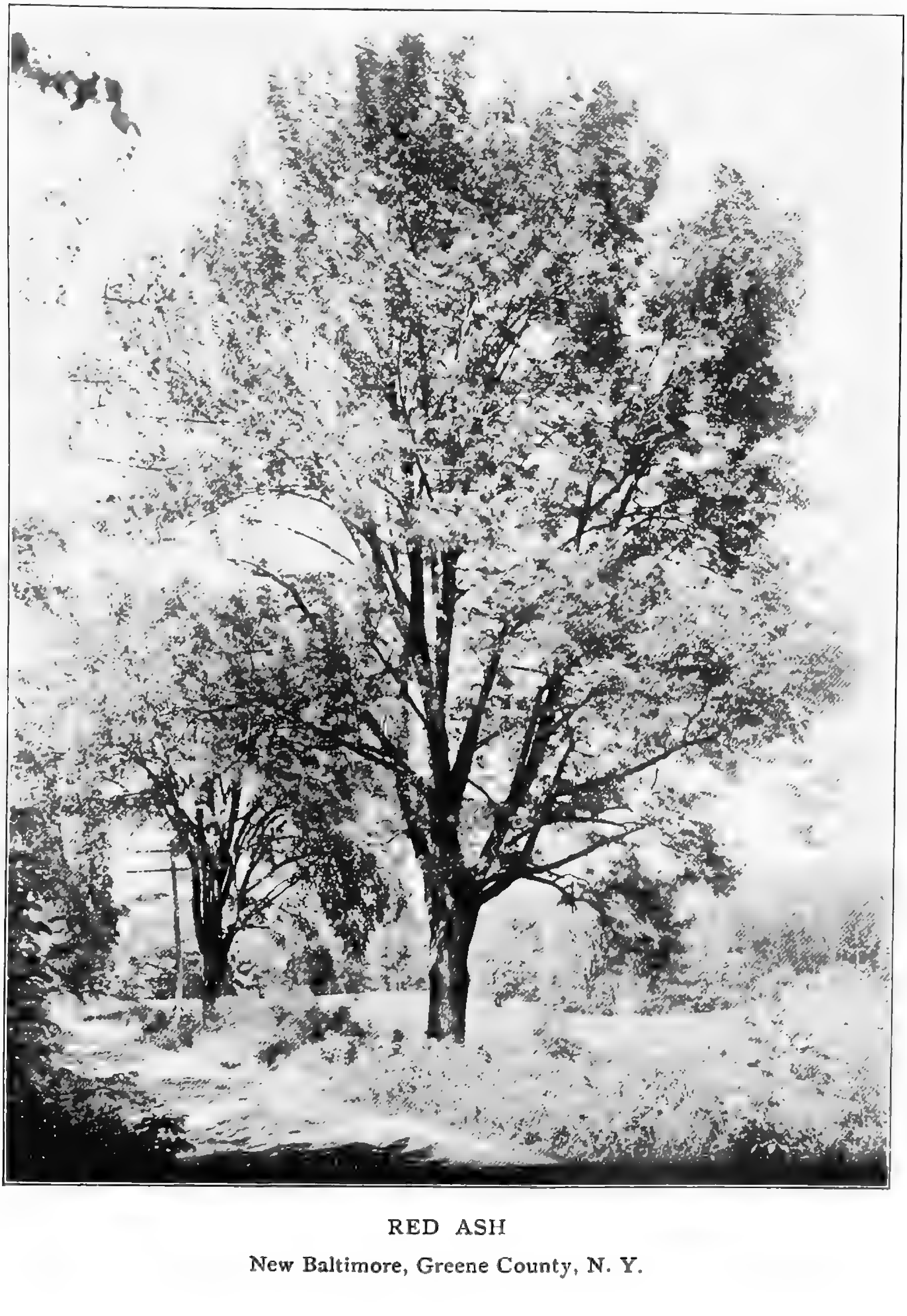
Red Ash FRAXINUS PENNSYLVANICA

This common and widely dispersed tree grows from Vermont to Florida and westward, and is plentiful throughout the Hudson Valley. Its average height is from 50 to 60 feet, and it not infrequently attains a trunk diameter of 5 feet. The bark is thick and furrowed, and usually brownish in color.

In the red ash there are 5, 7, or 9 thin, finely toothed leaflets that compose the compound leaf. They are in pairs, with a terminal one, and each leaflet is distinctly stalked, green on both sides, and from 1½ to 2½ inches long. In this ash the fertile and sterile flowers are borne on different trees. In both the sterile and fertile there are no petals and the flowers are greenish in color. From the fertile flowers subsequently develop the fruits which are winged; the wing is broader above the middle than below it and slightly notched at its tip. It may be from 1 to 2 inches long.

The wood of the red ash is much used in carpentry and wagon building, and the tree is desirable for street planting as it grows rapidly. (Plate 150.)

Darlington's Ash (*Fraxinus Darlingtonii*), a tree related to the red ash, is known to grow wild from Massachusetts to



RED ASH

New Baltimore, Greene County, N. Y.

central New York and southward, and may be distinguished by its fruits. In Darlington's ash the wings of the fruit are narrow, and practically parallel-sided, while in the red ash the wings are broader above the middle, the sides of the wing converge downward, and they are not parallel.

Michaux's Ash FRAXINUS MICHAUXII

As yet this tree is little known and its distribution not fully determined. It is known to grow from southern New York to North Carolina and specimens grow in the grounds of New York Botanical Garden, at Closter, New Jersey, and on Staten Island. Its general features resemble the red ash and its chief distinctive characteristics are the greater thickness of its leaflets and the greater width of the fruit. Their margins are practically smooth while in the red ash the margins of the leaflet are more or less toothed, except in rare instances.

White Ash FRAXINUS AMERICANA

Probably the best known and one of the most widely distributed of our native ashes. The tree prefers rich hillsides and in such situations often reaches a height of 120 feet. Its bark is thick, grayish-brown and irregularly fissured.

There may be from 5 to 9, usually 7, leaflets composing the compound leaf and each leaflet is distinctly stalked. They are sharp-pointed at the tip, rounded or acutish at the base, from 3 to 6 inches long and fine toothed or smooth on the margins. The under face of the leaflet is paler than the upper and is either hairy or quite smooth. As in the red ash the fertile and infertile flowers are, in the majority of cases, borne on different trees. Sometimes, however, both kinds of flowers may be found on the same tree, but in different flower-clusters. The fruits are winged above and the margins of the wing are either parallel or converge slightly downward. The seed-bearing part of the fruit is full and round, the wing arising from its upper end, and not running down the side of the seed.

Button Bush CEPHALANTHUS OCCIDENTALIS

Almost all the plants of the button bush are shrubs, but occasional trees may be found. In the grounds of the New York Botanical Garden a plant was cut out that had died, apparently from old age, which was a good sized tree of 25 feet or more. On old trunks the bark is dark brown or nearly black, and deeply fissured. The leaves are arranged in pairs or threes on the twigs. The blade is oval in outline, sharp-pointed at the tip and rounded or wedge-shaped at the base. In July the compact, ball-like clusters of creamy white flowers almost cover the plant. The fruits ripen late in the autumn and are arranged in densely compact ball-like heads, usually ¾ of an inch in diameter.

The button bush prefers swamps and the edges of streams and is common over the greater part of the United States. In the Hudson Valley it is common, but mostly as a shrub.

Sweet Viburnum VIBURNUM LENTAGO

This plant is often known as nannyberry and grows in rich soil from Ontario to Georgia and westward. It is common in the Hudson Valley, where it occurs as a shrub or a tree in about equal proportions. As a tree it reaches a maximum height of 30 feet and a trunk diameter of 8 to 10 inches.

The leaves, which are in pairs along the twigs, are bright green, smooth on both sides, oval or elliptic in outline, very rarely becoming roundish. The margins are sharply toothed, and the leaf-blade is 2½ to 5½ inches in length from its sharp-pointed base to the taper-pointed tip. The small white flowers are borne in large, almost stalkless clusters, and the collection of petals in the individual flowers are united at their bases.

In September its buish-black edible fruits ripen. They are scarcely ½ inch in diameter, covered with a bloom and contain a flat oval stone. The beauty of its autumnal foliage makes the plant desirable for decorative effects. Otherwise it is of little economic importance.

Black Haw VIBURNUM PRUNIFOLIUM

The black haw is more frequently a shrub than a real tree, although occasional specimens attain a height of 30 feet. It grows from Connecticut to Georgia and westward, and is very common along the lower Hudson, more rare northward. The stiff, spreading branches are usually armed with numerous prickle-like branchlets. The leaf-blades are smooth, from 1½ to 4 inches long, and essentially oval in outline. They are somewhat sharp-pointed at both ends and the margins are finely toothed. They are not taper-pointed at the tip and this serves as the chief distinction between it and the nannyberry. As in that species the flowers are arranged in an essentially stalkless flower-cluster. The petals are white and united below. The fruit is much the same as that of the nannyberry and is edible, usually being most prized after it has been frozen.

The plant is greatly in demand for decorative effects, and the bark of the roots and trunk is astringent. The wood is brittle and of little economic importance.

BULLETIN

OF

The New York Botanical Garden

Vol. 7. No. 24.

REPORT OF THE SECRETARY AND DIRECTOR-IN-CHIEF FOR THE YEAR 1909

(*Accepted and ordered printed, January 10, 1910*)

To the Board of Managers of the New York Botanical Garden.

Gentlemen: I have the honor to submit herewith my report as Secretary and Director-in-Chief for the year ending January 10, 1910.

Continued progress has been made in the work of the Garden. The system of driveways and paths has been much extended. A large amount of land has been improved by grading and drainage and made ready for planting. All the older plantations have been extended and improved. The completed portion of the second range of public conservatories was occupied and opened in June, relieving the crowded condition of conservatory range no. 1 and providing space for a fine display of the large collection of tropical ferns and cycads. The collections of living plants, museum objects, herbarium specimens and books have been materially increased, by gift, by purchase and by exploration. The labeling of plants and of specimens has been elaborated. Educational work has been continued with the general public, with children from the schools, with special students from colleges and universities, and by publications.

Maintenance of the institution has been accomplished by an appropriation of $79,520 for that purpose by the city of New York, supplemented by an appropriation of $13,480 made by the Board of Managers, or $93,000 in all; if the city appropriation had been sufficient the money voted for maintenance by the Board of Managers would have been available for educational work, for planting, and for the increase of the collections; a special fund of $6,850 was subscribed by members of the Garden for these purposes during the year. The permanent funds have been increased by $10,000 from the estate of the late William R. Sands, paid in full in June, and by several life membership fees and fees of students; the will of the late Helen C. Inslee provides $5,000 for the Garden subject to the life estate of her sister, Jeannette Robinson. Gifts of living plants, specimens and books during the year aggregated in value about $1,221.10 and have been recorded in detail in the monthly issues of the JOURNAL.

Construction work, including grading, drainage, extension of the water supply and the building of paths and roads, has been prosecuted by means of the balances of former city appropriations and by a new city appropriation of $25,000 which became available in August, 1909. Some minor pieces of construction, such as sodding and sowing banks, building catch basins, a temporary bridge, and laying drain pipes have been accomplished by laborers paid from Garden funds.

Grading and Drainage

Much of the season's work in grading and drainage has been carried out in the north meadows, in the northern part of the grounds, where there were a number of marshy areas which have been partially filled by earth hauled from various points within the grounds; this work has gone forward parallel with the building of paths in that part of the Garden, and several acres of low lying land have been reclaimed; at freshet time the Bronx River sometimes rises to the level of its banks through this flood plain and backs up into some areas, the level of which is lower than that of the river at flood; the work in this part of the grounds has been directed to the filling of these low areas sufficient to either prevent such flooding, or to shed the flood water as soon as the river falls; considerable filling is still required and work can profitably go forward there during another season. A large area, collectively, in the north meadows, may be sown and brought into lawn treatment in the spring. At the eastern end of the Boulder Bridge a marsh was transformed into a lake by excavating to an average depth of about three feet, and a canal to serve as an arm of the Bronx River was excavated from the Boulder Bridge southward through another marsh; the excavated material was used to form the approach to the Boulder Bridge from the east and for filling a stagnant pool south of the bridge; a small amount of work still remains to be done there. Considerable grading to form banks was also done at both ends of the Long Bridge over the Bronx River as well as at the Upper Bridge. The rough bank along the river road south of the Upper Bridge was regulated and graded, but not quite completed. Between conservatory range no. 2 and its boiler house, on the eastern side of the grounds, banks and slopes were regulated and graded and prepared for sowing in the spring.

All the rock needed for roads and paths under construction was excavated at the rear of the museum building and a considerable additional area there may be brought into lawn in the spring; much surplus earth was hauled from this point to the north meadows and elsewhere. The necessary excavation of the rock in order to properly grade the grounds at this point will supply all the stone necessary for the paths still to be built; this work has progressed slowly, but steadily and, as all the material is being used and is needed it is economical.

During the next year it is desirable that considerable grading be done along the eastern border of the Garden owing to the construction, along that line, of the boundary street known as the Bronx Boulevard, now in progress by the City Department of Public Works.

The building of this boundary street, already also called

Bronx Park East, will also necessitate the construction of permanent driveway and path entrances on the eastern side of the Garden, as contemplated in the original plan of development. From the southeastern end of the grounds northward to near the south end of the present nurseries the grade lies a little above that of the Garden ground, but the grades may be brought together here by a small amount of filling; from this point northwardly to the stable the grade lies below that of the Garden, forming a steep bank which may partly be treated by grading and will, in part, be a cliff excavated through ledges of rock; from the stable northwardly past conservatory range no. 2 to power house no. 2, the grades essentially agree, little work being required; but from power house no. 2 northwardly to the northeastern corner of the Garden grounds, the grade of the street lies above that of the Garden land, in some places as much as 22 feet. The Commissioner of Parks of the Borough of the Bronx has, at my request, called on the Department of Public Works for the building of a retaining wall between these points; if this were not done the filling needed for the bank to support this new street would come far out into the Garden grounds, burying a large number of fine trees and forming an unsightly feature, impossible of satisfactory landscape treatment. The matter was discussed by the President of the Borough of the Bronx, and his engineers, the Commissioner of Parks, and Mr. Schenck, his Chief Engineer, Mr. Samuel Parsons, Landscape Architect of the Park Department, and myself, at a conference held on December 31, 1909, and the building of this wall was agreed to.

Roads and Paths

The driveway approach to conservatory range no. 2 was finished and brought into use in the spring; the construction of the extreme northern end of this road is deferred until additional greenhouses of this range are built. The construction of the remaining part of the main driveway from near the stable to the southeastern entrance of the Garden, referred to in my last annual report, has been prosecuted from time to time, but its completion was deferred until the grading of the Bronx Boulevard was done at that entrance; this has now been accomplished by the Department of Public Works and the building of the last few hundred feet of the driveway is in progress; this will complete the driveway system of the Garden as planned.

In the building of paths, work has been mainly directed to those in the north meadows and the approaches to the Upper Bridge, where much progress has been made, and much more can advantageously be done there during the next season. The permanent path crossing the Boulder Bridge has been constructed; both sidewalks of the Long Bridge were built, and one of the sidewalks of the Upper Bridge; the foundations for paths at conservatories no. 2, temporarily used for roadways, were constructed. Two short lengths of paths were built near the station of the Harlem Division, New York Central Railroad and one in the fruticetum through the *Forsythia* collection, designed to afford more direct passage for persons walking from the Elevated Railroad Station to Williamsbridge. The path forming the rear approach to the west wing of the museum building from the western end of lake no. 1 was partly constructed.

Portions of paths previously built in various parts of the grounds and surfaced with coarse trap rock screenings were surfaced with fine screenings. The total length of paths completed during the year is about 2,125 feet, and the Telford foundations for about as much more were laid.

The charter of the Garden provides that for the maintenance of proper roads and walks, the grounds of the Garden shall remain subject at all times to the control of the Board of Commissioners of the Department of Parks. This duty has not been wholly efficiently carried out up to the present time, and the driveways have at times been in bad condition. Two men have been detailed by the Park Department for a portion of the season to keep the roads clean, but the large area of driveway has made this service insufficient; a single watering cart was provided during part of the year, but only covered a small portion of the driveways. Application was made to the Department early in the year for a supply of trap rock screenings to resurface worn parts of driveways and paths, but it was not received until just before cold weather set in; parts of the traffic road have long been worn into ruts; no labor has been provided by the Department for the maintenance of walks and it has been necessary to care for these, as well as for parts of the driveways, by laborers paid from Garden funds.

Bridges

None of the four stone bridges built in previous years have required any repairs.

The bridge planned by the Department of Parks to replace the present wooden bridge near the Lorillard Mansion, referred to in my last report, has not been constructed. During the season the old wooden bridge at that point was condemned by the Department as unsafe, and access to it shut off on both the Garden and Park sides of the river. Inability to cross the river at this point has been a great deprivation and annoyance to many thousands of visitors who have had to walk upstream to the Boulder Bridge, or downstream to the Linnaean Bridge for this purpose. I have been informed by the Park Department that money for this bridge was voted by the Board of Estimate and Apportionment a long time ago, but that it has not been possible up to the present time to award a contract for its construction. Plans were duly approved by all parties concerned in 1908.

In order to shorten the distance for hauling material for filling and path construction near the northern end of the grounds, a temporary wooden bridge was built late in the season across the Bronx River near the southern end of the north meadows, near a point planned for a permanent stone structure in the future. This was constructed by our gardeners and laborers in a few days, using chestnut timber throughout, the planks being hewn; the bridge is about 42 feet long and 12 feet wide. It will serve for several years and during its existence will be a reminder of the many chestnut trees formerly existing here, but now destroyed by the virulent chestnut blight for which no remedy has been found. Paths are being built to this bridge on both sides of the river.

Water Supply

The six-inch distributing main was extended during the year from a point near the Botanical Garden railroad station, New York Central Railroad, to the plaza north of the Lake Bridge, and from the plaza near the stable southwardly to a point opposite that building; hosetaps at intervals of about 200 feet were placed on it along both lines; two thousand feet of this pipe was obtained by contract during the season and about three hundred feet of this amount remains to be laid. This will be used in the spring, together with four thousand feet additional under contract for delivery, in continuing the distributing main northward from a point where it now ends in the fruticetum along the western side of the main driveway, crossing the Upper Bridge to the Newell Avenue entrance and southwardly along the river road to the Long Bridge where it will connect with the main already laid; it will also be possible to extend this main along the driveway now under construction southward from the stable, thus nearly completing the system, as planned.

Buildings

All the older buildings are in good repair. A considerable portion of the interior of conservatory range no. 1 was painted during the year, and its roof examined for defective glass; opportunity for doing this interior painting was afforded by moving the ferns and cycads to conservatory range no. 2, and successively emptying houses of conservatory range no. 1, it being impossible to properly paint the interior of a greenhouse without moving the plants; this interior painting of range no. 1 will be continued next summer. The leaks in the roof of the museum building, mentioned in my last report, continued to develop and were repaired only by relaying the greater part of the tile surface. The stable was painted, and some painting has been done on guard-rails and on the fence along the southern boundary from the Elevated Railroad Station to the Southern Boulevard.

The steam heating plant of the older buildings has required only ordinary repairs and replacements, but entailing somewhat increased expense over former years, and as the system becomes older the greater expenditure for repairs will be necessary.

Plans and specifications for a lakeside shelter house were transmitted, duly approved, to the Park Department in the autumn.

The four greenhouses of conservatory range no. 2 were opened to the public in the summer and the boiler house of this range was put into operation in the autumn. The construction and operation of these new buildings has been satisfactory, minor defects only having been found and readily repaired.

A new boiler was required for the propagating houses as well as minor repairs to the hot water heating pipes of these buildings.

Boundary Fences

The fence completed last year along the property line of Fordham University has required only a small amount of painting and is in good condition.

The proposed iron and concrete fence along the western boundary of the Garden to be built by the New York Central and Hudson River Railroad Company at the time their telegraph and telephone wires, now strung on poles along this line, are placed underground has not yet been commenced; the Railroad Company obtained permissive legislation during the year and I am informed that they intend to take the matter up in the spring.

The construction of the Bronx Boulevard along the entire eastern side of the Garden grounds will require that consideration be given to plans for a fence along that line.

Plants and Planting

Many plants have been transferred from the nurseries to the various plantations during the spring and autumn months, and many others have been purchased and suitably distributed. The planting has included additions and replacements in the herbaceous garden, the economic garden, the fruticetum, the arboretum, the pinetum, the ornamental flower gardens and the border screens, and additional trees and shrubs have been set out along the driveways and paths. In the autumn much planting was done at the eastern end of the Boulder Bridge and near the Long Bridge in the valley of the Bronx, utilizing, for the most part, wild shrubs moved from other parts of the valley, following the plan to keep the valley in as natural a state as possible.

Progress has been made in the development of lake no. 2 and its borders as an aquatic garden.

The completion of a part of conservatory range no. 2 made it possible to effect a considerable rearrangement of the greenhouse collections, much to their advantage, and a great many plants formerly in the propagating houses have been placed in the two large ranges for the inspection of the public.

Much attention and time has been given to the labeling of plants both in the grounds and public conservatories and records of the many additions have been carefully kept. Over 5,000 new labels have been prepared. These additions have been largely obtained from the work of the several exploring expeditions in the West Indies.

Contributions of money for the purchase of plants credited to the "Conservatory Fund" have been received during the year as follows:

Samuel Thorne	$200
Lowell M. Palmer	100

W. Bayard Cutting	100
James A. Scrymser	100
Robert W. de Forest	50

Hemlock Grove

The natural hemlock forest on the hills bordering the Bronx River continues to be a great attraction and except for the loss of the many chestnut trees, killed by the destructive chestnut blight, is in as healthy a condition as ever. The dead and dying chestnut trees have been removed during several previous winters and some are now being taken out by our gardeners under the observation of an official of the Department of Parks detailed for that duty, in accordance with the agreement between the Garden and that department; it is expected that this winter's work will remove all the dead trees. The loss of the chestnuts will not seriously impair the beauty of the grove nor impair its condition, because there are a large number of other deciduous trees, such as oaks, beeches, birches, hickories and maples remaining.

The notices posted at entrances to the grove, requiring visitors to keep to the trails, have been of considerable service in preventing indiscriminate trampling through the woods, but they are by no means wholly effective; their intention has been supplemented by men detailed as guards, but on days in summer when thousands of people come, it is impossible to restrict them as much as is desirable. As recommended in previous reports, it still seems to me desirable, in order to insure the safety of the hemlocks, that the trails be fenced.

In this connection I would state that during my visit to the Royal Gardens at Kew, England, in September, I was much interested in observing the treatment of the woodland there known at the Queen's Cottage Grounds, an area of some 40 acres through which had been outlined a circuitous grass path 13 feet wide fenced in with strong iron wire on both sides to a height of 4 feet, and the whole woodland enclosed by an iron fence with vertical bars about 5 feet high. This treatment has been found necessary there in order to preserve the woodland and its undergrowth of wild plants. I recommend the appointment of a committee to consider this important question and report to the Board.

Museums

Work on the public museums has been chiefly directed during the year to improving the arrangement of specimens, to adding additional specimens to the groups already installed, to the preservation and care of the specimens and to more complete labeling. Many plant products additional to those already displayed were added to the economic museum, and several exhibition cases were filled with sections of woods of West Indian trees collected on recent exploring trips.

Miss Katherine E. French was employed in the spring to prepare six wax models of flowering and fruiting branches of plants; if funds were available it would be very desirable to continue this work and secure a large number of such models, their especial value being that as they are practically a reproduction of the appearance of the living plant, flowers and fruits can be seen by the visiting public at all times, independent of flowering and fruiting seasons. The most satisfactory way of securing such a collection would be to employ a modeler as a member of the staff who would thus always be at hand to reproduce flowers and fruits at the Garden, and who might also be sent to other points to prepare models of plants not in the Garden collections.

Herbarium

The herbarium has been increased during the year by about 26,000 specimens, and some additional cases have been built by our carpenters. Much work has been given by the curators to the study of these additional specimens and to those incorporated in former years, so that the collection, as a whole, has been much improved for reference.

Inasmuch as such a large proportion of questions concerning plants have to be determined by reference to the herbarium it is important that it be continuously studied and its classification brought up to all published information concerning the names and relationships of plants.

Contributions of money credited to the "Museum Fund" and expended for the purchase of specimens were contributed during the year as follows:

William D. Sloane	$100
Chas. G. Thompson	100

Library

A count of the books on the library shelves made January 6, 1910, shows that this collection now consists of 21,708 volumes, an increase during the year of 478 volumes. There are also many thousand pamphlets. The additions have been obtained by exchange, and by purchase from ordinary Garden funds, but mainly by means of the special fund for scientific purposes subscribed by members of the Garden during the year. The following contributions to this fund have been credited to the purchase of books, but not wholly expended:

Andrew Carnegie	$500
Geo. F. Baker	250
Geo. S. Bowdoin	250
A. F. Estabrook	100
Edward V. Z. Lane	100
Thomas H. Hubbard	100
James Speyer	100
Francis Lynde Stetson	100
Addison Brown	100
Ernst Thalmann	100
H. C. Fahnestock	100
John E. Parsons	100

The visit of our Librarian, Dr. John H. Barnhart, to Europe for the purpose of selecting from the stocks of foreign bookdealers, works especially desirable for the library, proposed for last summer and referred to in my last annual report, has been deferred until the spring of 1910.

An additional steel bookcase was purchased and placed in the west library room, and an additional similar bookcase is now desirable.

Laboratories

Laboratory work with special students and visiting investigators has been continued during the year, 28 such special students having been registered. Only ordinary additions to the equipment of the laboratories have been necessary. The Director of the Laboratories has given special attention to the protection of living plants in the grounds from plant diseases and insect pests.

Monthly conferences of students and members of the staff have been held excepting during the summer, and records of the subjects discussed at these meetings have been printed in the monthly journal. Continuous rainfall and temperature records have been kept during the year; the rainfall was unevenly distributed and the grounds suffered at times from protracted drought.

The tropical laboratory at Cinchona, Jamaica, was occupied during the early part of the year by Miss Alexandrina Taylor, a former student of the Garden, and her mother; Miss Taylor continued there her studies on the life history of ferns. During our visit to Jamaica in the spring, Mrs. Britton spent some time with Miss Taylor at Cinchona in collecting and studying some of the rarer mosses of the Jamaica Mountains. Miss Taylor made very extensive collections of plants during her residence there, which have been partly incorporated in the Garden herbarium, but some are still being studied.

During a portion of the summer Professor F. O. Bower of Glasgow University, Scotland, was in residence at Cinchona engaged in similar studies and in the collection of material for subsequent work. During the last half of the year Dr. Forrest Shreve, a former student of the Garden, now on the botanical staff of the Carnegie Institution of Washington, was in residence at Cinchona engaged in certain physiological investigations with special reference to the growth of tropical forests.

Arrangements have been made for Professor Duncan S. Johnson of Johns Hopkins University, to visit Cinchona next spring with several students, the party being especially concerned with questions of morphology and physiology.

Lectures and Demonstrations

Spring and autumn courses of public lectures have been delivered in the lecture hall of the museum building on Saturday afternoons, as in previous years, mostly by members of the staff. The spring course commenced April 24 and ended July 10; the autumn course commenced October 2 and ended November 13. It is proposed to conduct a summer course this season, returning to a suggestion made two years ago, but not carried out.

Nature-study lectures and demonstrations to children and teachers of the public schools of the Borough of the Bronx were given in the spring and in the autumn, the total attendance being over 17,000.

Guides and Guide-Books

Aids and assistants have been detailed for the purpose of escorting visitors who applied for guidance through the grounds and buildings, as in previous years, and this system has been found very useful, in supplementing the installation and labeling of plants in the grounds and greenhouses and of specimens in the musems. Aids have also given personal guidance and instruction to classes of school children with good results.

In coöperation with the Hudson-Fulton Celebration Commission, a new descriptive guide to the grounds, buildings and collections, supplemented by a descriptive account of the native trees of the Hudson River valley, was published in August as Bulletin No. 23, and reissued as a guide-book, bound in stiff covers. This document has been kept on sale at the approach to the Elevated Railroad Station and at the museum building together with other publications of the Garden, picture postal cards and unmounted photographs. Trees in the Garden, of kinds growing naturally in the Hudson River Valley, were marked by a large letter H from August to October.

Exploration

The policy of sending members of the staff and special agents to conduct exploration in regions little known botanically, has been continued with excellent results; the collections of living plants and of specimens have been materially increased by this work and much addition to botanical knowledge has been made. It is most desirable that explorations be continued, especially in tropical America. All the material secured has a direct bearing on the preparation of "North American Flora," in course of publication by the Garden, and becomes available for other investigations, while many desirable plants for the greenhouses are also obtained.

The exploration work of the past year includes a visit by Dr. Murrill, Assistant Director, to the island of Jamaica for the purpose of studying and collecting the fungi of that island, he having been absent from December 5 to January 19, and his work added much to the knowledge of these plants. Dr. J. K. Small, Curator of the Museums, again penetrated the Everglades of Florida in company with Mr. J. J. Carter, devoting the month of January to this trip and secured a large collection which includes a number of species not heretofore known on the North American mainland. I was absent from the Garden from February 20 to April 14, accompanied by Mrs. Britton, and by Dr. Marshall A. Howe, one of our curators, continuing exploration work in Jamaica and in Cuba, and spent a week in returning from Cuba on the southern Florida Keys; over 10,000 specimens of all kinds were obtained during this trip. As mentioned in my last annual report, Dr. J. A. Shafer was sent to northeastern Cuba in January and collected plants and specimens there until early in May; Dr. Shafer visited, among other regions, some of the islands and cays laying off the coast of northern Cuba, and made the important discovery that a considerable number of plants, hitherto known only from the Bahama Islands, exist on these islands of Cuba; his general collections were also very large. Mr. W. W. Eggleston, a student of the Garden, spent a month in the spring and another month in the autumn in western Kentucky and discovered there a number of species not hitherto known to grow so far north or east. Mr. Percy Wilson, Administrative Assistant, was sent to the Bahamas early in May and spent a month in exploring the islands of the Cay Sal Bank, in order to make our exploration of the Bahamas more complete. Dr. H. H. Rusby, Honorary Curator of the Economic Collections, obtained a large number of valuable specimens for the economic museum during his trip to the Pacific coast during the summer. In October, Mr. Norman Taylor, an Assistant Curator, proceeded to the eastern part of the island of Santo Domingo, an island from which we have as yet very few specimens, and devoted two months to exploring there; he has just returned with an important collection. Dr. J. A. Shafer was sent again to northern Cuba in September and is still at work there. Late in November, Dr. Marshall A. Howe was detailed for the purpose of making a study of the algae of Panama, and is expected to return within a few days; letters indicating that his work has been successful, although the flora of the western ocean at this point was meagre in species, apparently owing to the great rise and fall of the tides, but on the Colon side of the isthmus a diversified algal flora was found similar to that of the West Indian waters. Dr. W. A. Murrill, Assistant Director, proceeded to southern Mexico in December for the purpose of obtaining additional information and specimens concerning tropical American fungi; letters received from him also indicate success and I anticipate his return in about two weeks.

This important exploration work has been made possible principally by contributions to the special fund for scientific and educational purposes, the following subscriptions having been credited to "Exploration Fund":

D. O. Mills	$1,000
J. Pierpont Morgan	500
James B. Ford	500
Mortimer L. Schiff	250
John Innes Kane	250
John D. Archbold	250
Edward S. Harkness	250
Geo. W. Perkins	250
Wm. K. Vanderbilt	250
N. L. Britton	250
Edgar L. Marston	100
Cleveland H. Dodge	100
Henry W. de Forest	100
Miss Elizabeth Billings	100
A. G. Agnew	50
Bernard G. Amend	50
James Douglas	50
Walter Jennings	50
Louis C. Tiffany	50
Mrs. Lawson Valentine	10
	$4,410

Investigations

In addition to the field studies accomplished by members of the staff while engaged in exploration, investigations have been prosecuted at the Garden by curators and other officers during such time as their administrative duties have permitted, much of this original research having been accomplished outside of regular hours of attendance. Investigations have also been prosecuted by students and by visiting officials from other institutions. Members of the staff have also visited other gardens, museums and herbaria for comparative studies on collections.

The results of many of these studies have been published during the year, such publication having been effected by the aid of the income of the David Lydig Fund bequeathed by the late Judge Charles P. Daly.

Research Scholarships

By means of an appropriation made for research scholarships, several students have been aided by allowances of $50 a month during residence at the Garden.

Mr. W. W. Eggleston was awarded a scholarship for three months to aid him in his studies of the North American thorns, preparatory to the publication of his monograph on the genus *Crataegus* in "North American Flora," and supplementary to his field work in Kentucky and other southern states.

Mr. D. R. Sumstine was awarded a scholarship for one month in the summer for aid in his investigations of North American moulds.

Mr. A. LeRoy Andrews held a scholarship for two months while studying the collections of peat mosses (Sphagnum), during the preparation of a monograph of this group for "North American Flora."

This study of the collections by specialists is of great advantage to them and many specimens have been contributed to the Garden by the holders of scholarships. Larger sums than those now available for scholarships could be expended very profitably, both as regards additions to knowledge and the increase in value of the collections themselves.

Preservation of Native Plants

Prizes for essays on the preservation of native plants and natural woodlands, made possible by the use of the income of the Caroline and Olivia Phelps Stokes Fund for the Preservation of Native Plants, were offered in the spring with interesting results, a number of such essays having been received from high school pupils. The existence of this fund has doubtless been a factor in stimulating public appreciation of the purpose for which it was established.

Police Protection

For police purposes, the Charter of the Garden refers the grounds to the control of the Department of Parks, but, as recorded in previous reports, the police protection has been quite inadequate and the increasing population in the vicinity of the Garden, as well as the increased number of visitors, require that additional service should be supplied. Up to the present time only a single patrolman has been secured for the entire tract, occasionally supplemented by one or two additional policemen. There has been considerable disorder about the grounds; a haystack was set on fire late in the autumn, and two fires of incendiary origin were set in the woodlands east of the Bronx River; labels of shrubs and trees have been stolen and some plants surreptitiously removed. To supplement the insufficient protection, we have had one keeper and two foremen sworn in as special officers and during the summer laborers and gardeners have been detailed as guards, thus reducing the available force for maintaining the grounds and plantations. It is earnestly hoped that additional police protection may be obtained this year.

Administrative

The details of maintenance have been carried out by Dr. W. A. Murrill, Assistant Director, acting under my general instructions, and by Mr. Percy Wilson, Administrative Assistant. The construction work has been under my own immediate direction, aided by Col. F. A. Schilling, Superintendent of Grounds, and I have personally supervised the increase of the collections and new installations. I have continued my investigations on the flora of the West Indies by personal study of the collections of the several exploring expeditions, and also those of the Cactaceae, commenced several years ago, in coöperation with Dr. J. N. Rose of the United States National Museum.

Financial Considerations

The sum $82,994.64, is provided by the city for the maintenance of the Garden during 1910, as against $79,520 for 1909, an increase of $3,474.64. This increase is a welcome addition, but the allowance is still insufficient to maintain the institution in its present development and to prosecute the important educational work to which it is committed; I have therefore recommended that $11,000 be appropriated to supplement the city allowance so as to have about $93,000 available for 1910, which is approximately the expenditure for 1909. This amount will probably suffice to keep the grounds, buildings and collections from any serious deterioration, but will not permit any considerable development.

The income of the Garden from its invested funds, from membership fees, sale of publications and other sources, is about $28,000 annually; taking this and the city allowance together, the funds available for expenditure aggregate about $111,000. As stated in previous reports, a total sum of about $125,000 is desirable in order that the Garden may be able to carry on its work to the best advantage; about $14,000 additional income is therefore desirable.

Reports Appended

Details of the work accomplished during the year will be found in the reports hereto appended, submitted by the Assistant Director, the Head Gardener, the Head Curator of the Museums and Herbarium, the Honorary Curator of the Economic Collections, the Director of the Laboratories, the Librarian, the Superintendent of Grounds, and a schedule of expenditures under appropriations made by the Board of Managers, submitted by the Accountant.

Respectfully submitted,

N. L. BRITTON,
Director-in-Chief.

REPORT OF THE ASSISTANT DIRECTOR

To the Director-in-Chief.

Sir: I have the honor to submit the following report for the year 1909.

Grounds

The same standard of economy and efficiency in the care of the grounds has been maintained during the past year as in former years.

The summer season was exceptionally dry and considerable watering was necessary. The autumn was dry and very late, the first film of ice appearing on the lakes November 19, and the first snow coming a week later. Steam was required in the conservatories several days later than in any previous year in the history of the Garden.

After the fall of the leaves in the hemlock grove, double guards were required both day and night for a time on account of the great danger from fire. Several small fires occurred, most of them in the forest east of the Bronx River, but they were promptly discovered and controlled. The Fire Department and the Police Department were called upon on two occasions and they responded very promptly. The forest fires fortunately did little damage owing to the dormant condition of the trees and the small area affected. The crop of hay gathered from the grounds during the summer and stacked in a barrack, amounting to over twenty tons, was badly damaged by fire in November.

The chestnut canker shows no signs of abating in virulence. The dead chestnut trees are being cut and used as rapidly as possible. The vacant areas left after their removal in the hemlock grove will afford space for young hemlocks to develop, thus continuing and extending the hemlock forest.

The imported elm-leaf beetle was abundant this year, stripping the elms of their leaves early in the season. A new spraying outfit was bought and the trees were sprayed once with arsenate of lead, but too late to be of much value. A systematic effort will be made next year in this direction, beginning early in May.

The lakes have been treated with copper sulphate as usual for the eradication of unsightly algae, and mosquitoes have been kept in control by the use of kerosene; these pests have been notably scarce during the past season.

Great interest has been exhibited in the collections by the public and by the teachers and students of the various educational institutions of this city and adjoining cities. Members of the staff and assistants assigned to guide duty have been taxed at times to meet the demands made upon them.

It becomes more evident each year that, as the collections increase in size and value, a more perfect system of guarding them will have to be inaugurated. That they have thus far escaped serious injury is largely due to the vigilance of members of the staff and employees out of working hours.

Buildings

The variety and extent of repairs to most of the buildings increases each year. The roof of the museum building has required considerable repairing during the year and the rooms on the basement floor of the east wing have been renovated and painted.

On the completion of the new conservatories and the removal of the cycads and ferns from the old range, several houses of the latter were completely renovated. Most of the cacti and many other plants, both at the public conservatories and at the propagating houses, were planted outside during the summer, and the houses thus made vacant were cleaned and painted.

The stable, the propagating houses, the new iron fence along the southern boundary of the grounds, and other structures needing attention have been repaired and painted as required. One of the boilers at the propagating houses was repaired, and the approach to power house no. 1 was concreted to preserve the wall and to afford an easy entrance for coal wagons.

The collections under glass are rapidly increasing in number and size. They are in good condition and continue to attract large numbers of visitors.

Publications

The importance of the publications of the Garden is now very widely recognized, and the subscription lists show a steady increase. Very little money is spent on advertising in other journals, although a small advertisement of our recent publications was inserted in *Science* several times during the year, with good results.

The inauguration of MYCOLOGIA necessitated a change in the editorship of the JOURNAL, which is now in charge of Mr. Percy Wilson, Administrative Assistant. The BULLETIN is edited by Dr. Arthur Hollick, Assistant Curator; and "North American Flora" by Dr. N. L. Britton, Director-in-Chief, Dr. J. H. Barnhart, Librarian, and myself.

JOURNAL

The JOURNAL has been published for each month during the year, making a volume of 308 pages with 19 plates and 37 figures.

MYCOLOGIA

This bimonthly periodical, devoted to fungi, was inaugurated in January and has appeared on alternate months throughout the year, making a volume of 290 pages with 16 plates and 5 figures. A feature of this publication is the illustration of fungi in their natural colors. Twenty species are thus illustrated in the first volume.

The following distinguished mycologists have assisted me with this periodical:

Joseph C. Arthur, Howard J. Banker, Giacoma Bresadola, Frederic E. Clements, John Dearness, Franklin S. Earle, Bruce Fink, Thomas H. Macbride, Paul Magnus, Narcisse

Patouillard, Lars Romell, Fred J. Seaver and Cornelius L. Shear.

BULLETIN

Bulletin no. 20, with 112 pages, was issued March 23, 1909. It contains the annual reports of the Director-in-Chief and other officers for the year 1908.

Bulletin no. 23, commencing Vol. VII, containing 148 pages and 40 plates, was issued August 27, 1909. It contains an illustrated guide to the grounds, buildings, and collections of the Garden, to which is appended a descriptive list of the native trees of the Hudson River valley. This Bulletin was published in coöperation with the Hudson-Fulton Celebration Commission.

Bulletins nos. 21 and 22 have not yet been published.

CONTRIBUTIONS

Contributions by members of the staff or students of the Garden reprinted during the year from other than Garden publications, are as follows:

No. 118. Studies of West Indian Plants—II, by Nathaniel Lord Britton.

No. 119. North Dakota Slime-Moulds, by Fred J. Seaver.

No. 120. Phycological Studies—IV. The Genus *Neomeris* and Notes on Other Siphonales, by Marshall Avery Howe.

No. 121. Reproduction by Budding in *Drosera*, by Winifred J. Robinson.

No. 122. Notes on North American Hypocreales—II. *Nectria Peziza*, by Fred J. Seaver.

No. 123. Experiments upon *Drosera rotundifolia* as to its Protein-Digesting Power, by Winifred J. Robinson.

No. 124. *Rhipsalis* in the West Indies, by N. L. Britton.

No. 125. Notes on *Rosaceae*—II, by Per Axel Rydberg.

No. 126. The Genus *Ceratopteris:* A Preliminary Revision, by Ralph Curtiss Benedict.

No. 127. The *Crataegi* of Mexico and Central America, by W. W. Eggleston.

No. 128. Studies on the Rocky Mountain Flora—XIX, by Per Axel Rydberg.

NORTH AMERICAN FLORA

This work, designed to include descriptions of all known plants native to North America, Central America and the West Indies, is being issued in parts at irregular intervals as rapidly as these parts can be prepared.

Volume 17, part 1, containing descriptions of the Family Typhaceae by Percy Wilson, the Sparganiaceae, Elodeaceae and Hydrocharitaceae by P. A. Rydberg, the Zannichelliaceae, Zosteraceae and Cymodoceaceae, Naiadaceae and Liliaceae by Norman Taylor, the Scheuchzeriaceae by N. L. Britton, the Alismaceae by J. K. Small and the Butomaceae and Poaceae (pars) by G. V. Nash, was issued June 30, 1909.

Volume 16, part 1, containing descriptions of the Family Ophioglossaceae by L. M. Underwood and R. C. Benedict, the Marattiaceae by L. M. Underwood, the Osmundaceae and Ceratopteridaceae by R. C. Benedict, and the Schizaeaceae, Gleicheniaceae, and Cyatheaceae (pars) by W. R. Maxon, was issued November 6, 1909.

MEMOIR

Volume III. Studies of Cretaceous Coniferous Remains from Kreischerville, New York, by Dr. Arthur Hollick and Dr. Edward Charles Jeffrey. viii + 138 pp., with 29 plates, was issued May 20, 1909.

Lectures

PUBLIC LECTURES

Two courses of illustrated public lectures on botanical subjects have been given in the museum building on Saturday afternoons, as follows:

April 24. "A Winter in Jamaica," by Dr. W. A. Murrill.

May 1. "Spring Flowers," by Dr. N. L. Britton.

May 8. "How Plants Grow," by Dr. H. M. Richards.

May 15. "Evergreens: How to Know and Cultivate Them," by G. V. Nash.

May 22. "Collecting Seaweeds in Tropical Waters," by Dr. M. A. Howe.

May 29. "Vanilla and Its Substitutes," by Dr. H. H. Rusby.

June 5. "The Selection and Care of Shade Trees," by Dr. W. A. Murrill.

June 12. "The Ice Age and Its Influence on the Vegetation of the World," by Dr. Arthur Hollick.

June 19. "Haiti, the Negro Republic, as seen by a Botanist," by Mr. G. V. Nash.

June 26. "Some American Botanists of Former Days," by Dr. J. H. Barnhart.

July 3. "An Expedition up the Peribonca River, Canada," by Dr. C. C. Curtis.

July 10. "Collecting Experiences in the West Indies," by Dr. N. L. Britton.

Sept. 25. "Native Trees of the Hudson River Valley," by Dr. N. L. Britton.

Oct. 2. "Some Floral and Scenic Features of Porto Rico," by Dr. M. A. Howe.

Oct. 9. "The Flora of the Upper Delaware Valley," by Mr. G. V. Nash.

Oct. 16. "Collecting Fungi at Mountain Lake, Virginia," by Dr. W. A. Murrill.

Oct. 23. "Autumnal Wild Flowers," by Dr. N. L. Britton.

Oct. 30. "Some Plant Diseases: Their Cause and Treatment," by Mr. F. J. Seaver.

Nov. 6. "The Reclamation of the Desert in San Bernardino Valley, California," by Dr. H. H. Rusby.

Nov. 13. "The Hudson River Valley before the Advent of Man," by Dr. Arthur Hollick.

SCHOOL LECTURES

The usual series of lectures and demonstrations to the public school children of the 4B and 5B grades, of the Borough of the Bronx, was given in spring and autumn, under the auspices of the Board of Education in connection with the nature study work of the schools; 16,895 children, accompanied by their teachers, attended these exercises.

Grade 4B

Lecture I, "Cultivation of Plants," by Mr. George V. Nash, was given to groups of pupils on April 29, May 3, May 4, October 19, October 21 and October 22.

Lecture II, "Seedless Plants," by Dr. Marshall A. Howe, on May 6, May 13, May 18, October 13, October 14 and October 15.

Grade 5B

Lecture I, "Woody Plants and Plants without Wood, Protection of Trees in Cities," by Mr. F. J. Seaver, on April 22, April 26, April 27, October 26, October 28 and October 29.

Lecture II, "Industries Depending Upon Forests. Plant Products," by Dr. H. H. Rusby, on May 5, May 11, May 14, November 1, November 5 and November 9.

Lecture III, "Classification of Plants," by Dr. N. L. Britton, on May 20, May 21, May 25, November 11, November 12 and November 16.

Scientific Meetings

The Conferences, held in the library on the first Wednesday of each month, have been unusually successful. A report of each meeting is published in the current number of the JOURNAL.

The Torrey Botanical Club has held its usual monthly meetings on Wednesday afternoons during the year in the morphological laboratory of the museum building.

At the Darwin Memorial Celebration of the New York Academy of Sciences, held February 12, the Garden made twelve exhibits showing the application of Darwinian principles to plants, and Dr. N. L. Britton, Director-in-Chief, delivered the address on "Darwin and Botany."

The Dutchess County Horticultural Society visited the

Garden in a body on May 27 and made an inspection of the collections.

The Horticultural Society of New York held its summer exhibition in the museum building on June 5 and 6.

The Hudson-Fulton Celebration, in October, was participated in by the Garden in several ways, as described in the August number of the JOURNAL. A special Guide Book was published; the native trees of the Hudson River Valley growing on the grounds were marked with a large "H"; and two lectures of the autumn course were devoted to the subject. On October 2, 2,400 school children in costume held a historical fête on the plaza in front of the museum building.

Personal Investigations

In January, 1909, I returned to New York with about 3,300 specimens of fungi collected at fourteen selected localities in Jamaica, with full field notes on fleshy species, and over two hundred colored illustrations of the more interesting ones made by Mrs. Murrill. A full account of our explorations appeared in the JOURNAL for February, 1909. This collection has been only partially worked over, but the indications are that it contains over 100 undescribed species.

Shortly after my return, the first number of MYCOLOGIA was published, and this journal has demanded a considerable portion of my time during the year, not only in managing and editing it, but also in contributing technical articles and reviews of current literature.

My most important scientific work of the year has been the completion of a monograph of the Boletaceae of North America, which will appear in Volume 9, part 3, of "North American Flora." A preliminary arrangement of most of the North American species of this family was published in MYCOLOGIA earlier in the year. The species of Chantereleae, the lowest tribe of the gill-fungi, were also monographed for Volume 9, part 3, of "North American Flora."

The arrival of an important collection of polypores from Japan for determination led me to make a study of the

Japanese species of this family and to publish an article on the collection, with descriptions of several new species which it contained. A later collection, exclusively from Formosa, was also studied and reported upon. All of the Philippine, Japanese, and other oriental species of this family have been arranged together for the present in the mycological herbarium, the North American and European species forming two other distinct groups.

During a vacation of two weeks in July, I visited Mountain Lake, Virginia, and collected nearly a thousand specimens of fungi, mostly large and fleshy species. The fungi of this region had been almost entirely neglected up to this time. On my return, the local species claimed my attention far into November. Large collections were also sent me by Mrs. C. E. Rider from Chappaqua, New York, and by Professor Bruce Fink from Ohio and Kentucky.

On December 2, with your permission, I left New York for southern Mexico to collect and study the fungi of certain selected localities.

Respectfully submitted,
W. A. MURRILL,
Assistant Director.

REPORT OF THE HEAD GARDENER

Dr. N. L. Britton, Director-in-Chief.

Sir: I have the honor to submit the following report for the year 1909.

Systematic Plantations

Herbaceous Grounds. The collection of herbaceous plants contains about 2,800 species. Show labels for this collection have been prepared as follows: wooden, 375 individual, 11 family; lead 11; total 397. The lily bed was made over by digging out the old soil to a considerable depth and replacing it with a compost more suitable for the plants. A considerable number of species were added to the lily collection.

Fruticetum. There are now in this collection about 1.500 specimens, illustrating, with some few still at the nurseries, about 710 species and varieties. To those already in position there have been added during the year 159 show labels.

Salicetum. This collection becoming somewhat crowded by the growth of the specimens, it was decided to remove a certain proportion, that those remaining might have a better chance to develop. The collection now contains 45 species and varieties, represented by about 100 specimens. Show labels to the number of 23 have been placed in position.

Deciduous Arboretum. The collection of deciduous trees contains about 262 species and varieties, including some still at the nurseries and those native to the tract. To those already in position 152 show labels have been added during the year.

Pinetum. The collection of conifers, including those still at the nurseries, contains 272 species and varieties; there are 950 specimens in the pinetum. There have been 132 show labels added during the year.

VITICETUM. To the vines already represented in this collection 5 species have been added, making the total now 45.

CONSERVATORIES. When the new conservatories, known as range no. 2, were ready for occupancy in June, a portion of the collection, hitherto located in the old conservatories, was transferred to the new. This transferral included the tropical fern collection and related groups, and the collection of cycads. The plants installed at the conservatories and at the propagating houses represent about 205 families, 1,425 genera, and 8,150 species and varieties, with a total number of specimens of about 21,766.

Range no. 1. The removal of the plants referred to above required a rearrangement of the collections here. The transferral of the tropical ferns left houses nos. 10 and 11 vacant. The aroids, bromeliads, and pitcher-plants, hitherto in house no. 2, were removed to house no. 10. The banana, ginger and canna families, forming a part of the collections in houses nos. 3 and 4, took the place of the tree-ferns in house no. 11. The removal of the cycads from house no. 1, and the placing of the smaller specimens of palms in house no. 2, gave opportunity for the spreading out of the collection of palms; this has resulted in great benefit to the specimens, many of which were becoming crowded in their former positions. The removal of the plants of the banana and ginger families from house no. 3 afforded needed room for the spreading of the collections still remaining in that house. The elimination of the same families from house no. 4 provided room, not only for the better display of the remaining plants in that house, but also furnished space for many plants in houses nos. 7 and 8 which were becoming much too crowded. The above removals, something over 1,000 plants, and the readjustments occasioned thereby, have made no appreciable differences in the appearance of the houses, thus indicating the great need for the new conservatories, on account of the crowded conditions in the old. To accommodate the increasing collections, it will soon be desirable to build another portion of the new range. There have been added 2,798 show labels during the year, of which number 2,615 were zinc and 183 lead. Signs giving information as to the location of plants removed from this range were placed where necessary.

In this range there are now 10,718 plants, distributed as indicated in the following table:

House no.	1	214	House no. 9	200
	2	221	10	930
	3	502	11	285
	4	535	12	624
	5	1,562	13	482
	6	873	14	722
	7	820	15	1,645
	8	1,103		

Range no. 2. The tree-ferns and the larger specimens of the other ferns and related groups, transferred from range no. 1, have been placed in the middle and west houses of the transverse range; the east house has been allotted to the collection of cycads. The remainder of the ferns and related groups have been located in the low north and south house. They have been arranged in botanical sequence, the details of which have already been described in a recent number of the Garden JOURNAL.

The total number of plants in this range is 1,167, distributed as indicated in the following table:

West house. . . .	76	East house. . .	48
Middle " . .	120	Low "	923

Show labels to the number of 413 have been prepared and placed in position; of this number 342 were of zinc and 71 of lead.

PROPAGATING HOUSES AND NURSERIES. As for a number of years past, a great part of houses nos. 5 and 6 has been occupied by the cactus and orpine families, and a portion of house no. 4 has been reserved for the use of the Director of the Laboratories. In the remaining houses are duplicates, mainly of young plants to replace old ones when these are needed, many seedlings, and certain plants which require special treatment.

From sources outside of the collections there have been received 1,331 packets of seeds; of these 38 were by gift, 1,247 by exchange, and 46 collected by members of the staff. There have been collected in the various plantations 653 packets. The propagating houses, including the cold frames, contain 9,874 specimens.

LABELING, RECORDING AND HERBARIUM. The details of this work have been under the direction of Mr. Richard C. Schneider, custodian of the plantations, who has had to assist him one gardener, and an apprentice for two months during the summer.

In addition to 650 lead show labels repaired, there have been made the following new show labels of various kinds:

Arboretum		152
Herbaceous Grounds		397
Morphological Garden		39
Economic Garden		57
Border at Elevated Approach		99
Salicetum		23
Fruticetum		159
Pinetum		132
Trees along driveways and paths		583
Conservatory decorative beds		278
Conservatory lily pools		29
Conservatory range no. 1	2,798	
2	413	3,211
		5,159

Accession numbers 29,938-31,776 have been recorded during the year, making a total of 1,839 accessions. There have been derived from all sources 5,526 plants, divided as follows: by gift, 337; by exchange, 515; derived from seeds, 1,457; from collections by members of the staff and others, 518; by purchase, 1,457; by propagating, 1,242.

To the herbarium of cultivated plants have been added

527 specimens, of which 331 were from the outside collections and 196 from those in the conservatories.

The following table gives the approximate number of kinds of plants in each collection:

Conservatories	8,150
Herbaceous Grounds	2,800
Fruticetum	710
Deciduous Arboretum	262
Pinetum	272
Salicetum	45
Viticetum	45
	12,284

Miscellaneous Plantations

Morphological Garden. This collection has continued to attract much attention from visitors. There have been 39 show labels added.

Economic Garden. Some of the beds in this collection were enlarged, especially those devoted to the fodder plants, larger patches of these giving a better idea of the manner of growth and general appearance. There have been made 57 show labels for this collection.

Desert Plants. In addition to the collection of American desert plants hitherto displayed in the summer in the court of conservatory range no. 1, desert plants from other parts of the world were made a part of the exhibit. The center bed, as heretofore, was devoted to the American forms. A portion of the plot east of this was given to plants from the desert regions of southern Africa, represented by such genera as *Aloe*, *Mesembryanthemum*, *Gasteria*, *Euphorbia* and others. In a corresponding westerly plot a bed was made and devoted to the orpine family, a group of plants illustrating the distribution of a single family in dry regions in both the Old World and the New. These three beds have attracted much attention, offering as they do a comparative study of the desert flora of various parts of the world.

Conservatory Lily Pools. The collection of water lilies here brought together has been a source of great pleasure to the public. The continued cool weather of the early part of the season, when the plants were still young, interfered with their best development, this being especially noticeable in the *Victoria*, which failed to bloom this season. There were made for this collection 29 new show labels.

CONSERVATORY FLOWER GARDEN. The two large beds on the north side of conservatory range no. 1 have been maintained and a number of additions made to them, mainly bulbous plants. During the spring the two remaining grass plots, at either end of those already developed, were planted with a mixed center of evergreens and deciduous shrubs, with an 8-foot border of herbaceous plants. To those already in position, 278 show labels have been added.

FLOWER GARDEN AT THE ELEVATED APPROACH. Ground for this had been broken up in the fall of 1908 and was in excellent condition the following spring for immediate development. This planting, of irregular width, forms a border to the decorative shrubs installed there, and continues from the entrance to the approach to the border paralleling the Harlem Railroad. Annuals and herbaceous perennials, with some tender plants such as heliotrope, castor-oil plant, verbenas and others, were used in its development. The collection is a varied one, containing many of the old-fashioned flowers; there being no duplicates, many kinds can be shown in a comparatively small area. For this collection 99 show labels were made.

WEST BORDER. That portion of the west border, extending from the Bedford Park Boulevard entrance to the Harlem Railroad Station plaza, was entirely replanted during the fall. Much of the old material, representing duplicates, was dispensed with, and many other plants, new to the decorative collections, were added. Duplication was also avoided in this border, so that a display of many kinds is obtained in a comparatively small space. A large number of bulbs, representing species and varieties not hitherto in the decorative collections, were added.

AQUATIC GARDEN. The middle lake (lake no. 2) of the chain of three, north of the museum building, is being developed as an aquatic garden. The lake border and its vicinity were partly planted with shrubs, trees and perennial plants thriving in such locations; much work along this line has been accomplished both during the spring and fall. A strong colony of the yellow lotus, a native of this country, has been established in the cove near the Lake Bridge, its stately shield-shaped leaves forming an attractive feature in that portion of the lake. Around the margins in the water have been planted our native water lilies and some of the more vigorous hybrids. This garden has attracted much interest during the past summer and has been much admired.

General Horticultural Operations

The available force consisted of 2 foreman-gardeners, 20 gardeners, 2 apprentices and 16 laborers. In addition to these there were 3 drivers for mowing and hauling, two for the entire time and the other one during the continuance of the mowing season.

This force was detailed as follows: 1 foreman-gardener, 13 gardeners and 2 apprentices to the conservatories and propagating houses; 1 foreman-gardener, 7 gardeners and the laborers to the work outside.

A foreman-gardener, Richard Richter, was made responsible for the care of all the plants under glass, with his main duties located at the conservatory range no. 1, a gardener being placed in charge, under his direction, at both the propagating houses and at conservatory range no. 2.

The force apportioned to conservatory range no. 1, after the removal of certain portions of the collections to the new range, consisted, in addition to the foreman-gardener, of 9 gardeners and 1 apprentice, these attending also to the decorative planting in the immediate vicinity and to the flower beds and urns at the fountain at the foot of the Museum approach; it was found necessary to temporarily dispense with the services of three gardeners during the fall. At conservatory range no. 2, upon its occupation in June, were employed 1 gardener and 1 apprentice. At the propagating houses 3 gardeners and 1 apprentice were necessary, the latter only being available during the continuance of the outside work.

The force apportioned to the outside work, in charge of John Finley, foreman-gardener, was divided as follows: museum tract, 1 gardener and 1 laborer; conservatory tract, 1 gardener and 2 laborers; west border tract, 1 gardener and 1 laborer; fruticetum tract, 1 gardener and 3 laborers; herbaceous grounds tract, 1 gardener and 5 laborers; deciduous arboretum tract, 1 gardener; lake tract, 1 gardener; for miscellaneous operations, including the scythe work and the care of the walks, 4 laborers.

In addition to the new planting at the conservatories, and the planting of the new border, to which reference has been made above, considerable general planting was accomplished. During the spring the following work was done: in the north meadows a number of sweet gum trees were set out along the driveway, to replace some of a previous planting which had died, and 9 swamp oaks were planted along the same driveway; at the west end of the long bridge conifers were placed between the driveway and the path on the south side, and on the bank and low-lying ground below a beginning was made in the establishment of a conifer group, by the planting of some spruce and white pines; across the driveway from the conifer planting above referred to, a group of *Ribes curvatum* was used in the narrow point between the roadway and path; 2 shade trees were located on the north path of the west lake near its westerly end; at the Bedford Park Boulevard entrance, near the railroad bridge, the group of aralias was enlarged; the ends of the southern side of the fountain enclosure, at the foot of the museum approach, were planted with *Ilex crenata*, 5 on each end; in the unoccupied area in the vicinity of the men's comfort station at the approach to the elevated railroad a number of conifers were placed, enlarging the group already there; 2 shade trees were placed along the south path, on the north side, between the knoll and the south gate; 3 maiden hair trees were added to the collection near the south gate, placed along the path; the corners formed by the path entering the herbaceous grounds, near the south gate, were planted with *Rosa rugosa*.

During the fall much planting was done. A number of trees, 7 black ash and 3 buttonwoods, were set out along the driveway in the fruticetum and north meadows. At the west end of the long bridge, on the south side, a planting of *Ribes curvatum* was made, corresponding to that on the opposite side of the driveway; at the east end of the same bridge, on the north side, there was planted a group of the honeysuckle family, extending from the end of the bridge along the path and down the hillside. The piers on the south side of this bridge, on both sides of the river, were planted with cornus and spice-bush, obtained on the ground. About 50 plants of the common honeysuckle were placed among the boulders forming the low wall along the roadway north of the long bridge and east of the river. In the vicinity of the boulder bridge a large amount of planting was accomplished, the greater part of the material used (the wild rose, sweet pepper-bush, cornus, spice-bush, buttonbush, elder-berry, viburnum and others) being secured in the north meadow; the areas on the north and south sides, extending from the river around the bend in the path, and the island to the south of the bridge, were thus treated; the immediate approaches of the bridge on the east end, and a portion of the beds on the bridge proper, were planted with wax-berry and sweet-fern, secured by purchase; the triangle formed by the paths near the tulip-tree row was planted with *Viburnum molle* and *V. acerifolium*, also purchased. The planting of the triangle near the aquatic garden was completed with material secured wild and from the other collections. The easterly side of the south gate was planted with Japanese barberries, thus making it correspond with the westerly side. The usual horticultural operations were carried on during the year, including the pruning and spraying of shrubs and trees; top-dressing of lawns and around trees and shrubs; protection of the half-hardy plants; the gathering and storing of fallen leaves for the production of leaf-mold; and much other work.

Investigations

In addition to my ordinary duties, I have continued my investigations on the grasses for the "North American Flora," and have submitted for publication in the same work the manuscript of the Tropaeolaceae.

Respectfully submitted,
GEO. V. NASH,
Head Gardener.

REPORT OF THE HEAD CURATOR OF THE MUSEUMS AND HERBARIUM

Dr. N. L. Britton, Director-in-Chief.

Sir: I have the honor to submit the following report for the year 1909.

The several collections under my care have been maintained as heretofore, and increased as indicated below:

Accessions

(*a*) Series of specimens and various special collections, making a total of 6,236, were acquired by purchase.

(*b*) Gifts amounting to 3,347 specimens were received.

(*c*) Exchanges with other institutions and individuals added 6,113 specimens to the collections.

(*d*) Exploration in various parts of North America resulted in bringing together 23,459 specimens.

The total number of specimens accessioned during the year is 39,155.

Museums

The public exhibits were enlarged as specimens were received. The specimens already installed were kept in order and cleaned as occasion demanded. Labeling proceeded as rapidly as specimens were installed.

Fossil Plant Museum. The majority of the specimens added to this museum are from western North America. About one half are of recent collection. The remainder, belonging to the J. S. Newberry collection, were found during the year in storage at Columbia University.

The tentative general arrangement of the exhibits adopted last year was found to be the most advantageous for the display of the specimens now comprising the collections. Many changes, however, were made in individual specimens. The cases containing carboniferous plants and those showing the fossil flora of the vicinity of New York City, of New

Jersey, Staten Island, Long Island, Block Island and Martha's Vineyard were practically reinstalled.

ECONOMIC MUSEUM. Many miscellaneous specimens were added to the collections of this museum, and especially valuable representatives of drugs, argols, lees, fruits and other vegetable foods were received. Several exhibition cases were devoted to sections of the trunks of West Indian trees, which were collected on recent trips of exploration to insular tropical America. (For details see report of the Honorary Curator of the Economic Collections.)

SYSTEMATIC MUSEUM. The several components of this museum were enlarged where possible and otherwise improved. The general arrangement and the sequence of groups remained as heretofore.

The Synoptic Collection was augmented mainly by the addition of specimens collected or acquired by members of the Garden staff on trips of exploration.

The experiment, undertaken several years ago, to ascertain the value of models in the public exhibits was continued. Accordingly, a half dozen wax models of flowering and fruiting branches of representative examples of several plant families were made and installed. The use of such models seems to be desirable.

The Local Flora was partially renovated and relabeled. Many new specimens were set aside for future use in this exhibit.

The Microscope Exhibit was modified from time to time and was given a general renovation, in connection with the preparation of the new edition of the "Descriptive Guide to the Grounds, Buildings and Collections," published during the year.

Herbaria

The herbaria have been increased by the acquisition of specimens from various parts of the Old World, particularly from the Philippine Islands, and by numerous specimens from Canada, the United States, Mexico, the West Indies and parts of South America. Nearly all of these additions bear directly upon the active work of the Garden.

The M. A. Howe herbarium, comprising representatives of all the larger groups of plants, particularly from western North America, but especially rich in the bryophytes of the Pacific slope, is an important addition to the collections.

MOUNTING AND CONSERVING OF SPECIMENS. Selections from our stock of unmounted herbarium specimens and from the accumulation of the year, amounting to about 26,000 specimens, were mounted on 20,204 sheets of herbarium paper, and incorporated in the permanent collections. The herbarium sheets of the groups monographed in the current parts of "North American Flora" have been named in accordance with the nomenclature adopted in that work, and the specimens properly arranged in the herbarium cases.

GARDEN HERBARIUM. The unequal growth and the rapid increase of this collection necessitated the general shifting of specimens several times during the year. The installation of several new herbarium cases toward the end of the year also necessitated the rearrangement of many plant families.

COLUMBIA UNIVERSITY HERBARIUM. Several hundred sheets of both flowerless and flowering plants were mounted and incorporated in this collection. Many old specimens were repaired, and those of groups being used in connection with work on "North American Flora" were securely attached to the herbarium sheets.

DUPLICATE HERBARIUM SPECIMENS. A total of 3,773 specimens were sent to institutions and individuals in exchange for other specimens.

Assistance and Investigations

Dr. Arthur Hollick, Curator, has had charge of the care and development of the fossil plant collection. In addition to arranging the public exhibits, Dr. Hollick has continued his studies of previously unnamed specimens, and developed the catalogue of the many figured and type specimens of the collection. In this work he has had the voluntary assistance of Mr. Edwin W. Humphreys.

Dr. M. A. Howe, Curator, has cared for the collections of algae and hepatics. He continued his studies and descriptive work in the North American algae, and collected algae and other cryptogams in Jamaica and Cuba during the early part of the year and in Panama during the latter part. Dr. Howe continued to serve as editor of the Torrey Botanical Club, having special charge of its BULLETIN and MEMOIRS. He also assisted in the nature study course given at the Garden in coöperation with the public schools of the city.

Dr. W. A. Murrill, Assistant Director, and Mr. F. J. Seaver, Director of the Laboratories, conserved and developed the collections of fungi. (For particulars see the reports of the Assistant Director and the Director of the Laboratories.)

Mrs. N. L. Britton continued to lend her voluntary aid in the developing of the moss collection. Besides vigorously pushing forward the incorporation of the Mitten moss herbarium in the collections, she has had the duplicates of the Mitten herbarium prepared for sending to other institutions as exchanges, and has supervised the preparation of a card catalogue of all the North American mosses enumerated in the "Pflanzenfamilien." Mrs. Britton has named collections of mosses made by herself in both Cuba and Jamaica, and has given critical study to several genera for a forthcoming part of "North American Flora."

Mr. R. S. Williams, Assistant Curator, has had charge of the collections of lichens. He has coöperated with Mrs. Britton in the development of the moss collection and in the naming of recently acquired specimens and has also done a considerable amount of work on Mexican and Central American mosses; and the genera *Campylophus*, *Campylopodium*, *Dicranella*, *Dicranum*, *Oncophorus* and *Leucoloma* have been monographed, for publication in "North American Flora." Mr. Williams also assisted in the nature study courses at the Garden in coöperation with public schools of the city.

Mr. Norman Taylor, Assistant Curator, devoted his time largely to the study and collection of the local flora by both herbarium and field work. Mr. Taylor prepared an account of the trees of the Hudson River Valley, which was published in the Hudson-Fulton Celebration issue of the Descriptive Guide to the grounds, buildings and collections, and completed monographs of the four families of the order Naiadales, which were published in "North American Flora." The months of November and December were devoted by him to exploration in Santo Domingo, West Indies.

Dr. P. A. Rydberg, Curator, cared for the herbarium of flowering plants. He has continued his work on the flora of the Rocky Mountain region. His monographs of Sparganiaceae, Elodeaceae and Hydrocharitaceae were published in "North American Flora," while those of Balsaminaceae and Limnanthaceae are ready to go to press. Dr. Rydberg also revised a manuscript of the family Zygophyllaceae for the same work, and printed several minor papers in the BULLETIN of the Torrey Botanical Club and the JOURNAL of the Garden.

Mr. W. R. Maxon, an Assistant Curator of the United States National Museum, spent two months in studying and arranging the collections of ferns and in preparing monographs of several fern families for "North American Flora" and some work has been done on the fern collections by Mr. R. C. Benedict, Fellow in Botany, Columbia University.

The writer, in addition to curatorial details, has continued his studies on North American plants, and the relationships of plant genera and families. Further investigations on the flora of tropical Florida were prosecuted both in the herbarium and in the field, the month of January being spent in exploration.

My monograph of Alismaceae was published in "North American Flora," while that of the Malphighiaceae is ready for publication. Respectfully submitted,

J. K. SMALL,
Head Curator of the Museum and Herbarium.

REPORT OF THE HONORARY CURATOR OF THE ECONOMIC COLLECTIONS

Dr. N. L. Britton, Director-in-Chief.

Sir: I have the honor to submit the following report for the year 1909.

The number of specimens added to our economic collection during the year is 212. These specimens consist chiefly of drugs and edible products contributed by myself. About half of them have been obtained from commercial sources. Of the others, a small collection was made in the vicinity of Charleston, S. C., in March, another in the vicinity of Mt. Airy, N. C., in June, and a large collection, specifically reported upon in the October number of our Journal, in British Columbia, Washington, Oregon, California, Arizona, New Mexico and Colorado, in July, August and September. I would direct your special attention to the authenticated character of these specimens, inasmuch as they are, in nearly all cases, accompanied by herbarium specimens, the labels of each bearing a cross-reference to the other. These two specimens have, whenever possible, been taken from the same plant. It thus becomes possible for students and investigators, in referring to the museum specimens, to verify their identity by the herbarium specimens, even though a species should later have been divided or merged, or its name brought into doubt in other ways. The importance of this method of building up our museum can not be overestimated. It frequently happens that important commercial or legal questions depend for their settlement upon the authenticity of a museum specimen which, when the latter is referred to, cannot be established. Aside from this fact, the scientific study of a herbarium specimen is often greatly aided by the examination of other parts existing in a museum specimen. Many of the specimens here reported upon represent fleshy fruits, preserved in formaldehyde solution, with their natural form and color retained. Our museum now contains so many specimens collected in this way that they begin to impart to it a distinctive character, and I respectfully urge upon you the importance of fostering this plan of development, so far as our funds will permit.

I referred in my last annual report, to an important economic collection made for us in northern Brazil, by Messrs. Weiss and Schmidt. It was my expectation to have finished the naming of this collection during the past year, but this has been impossible. Most of the specimens are not represented in any form at the Garden, so that the work of determination is difficult and requires much time. It will be continued during the coming year.

The labeling of our materials has, with few other exceptions, kept pace with its accumulation, and I am able to report the museum as being in an excellent condition in every respect.

Respectfully submitted,
H. H. Rusby,
Honorary Curator of the Economic Collections.

REPORT OF THE DIRECTOR OF THE LABORATORIES

Dr. N. L. Britton, Director-in-Chief.

Sir: I have the honor to submit the following report for the year 1909.

No extensive changes have been made in the laboratories or laboratory equipment during the past year. Necessary supplies for student work conducted at the Garden have been purchased from time to time but these have not necessitated the expenditure of any large sum of money. As a temporary arrangement, a corner in the chemical laboratory has been used as a mounting room during the entire year.

Dr. W. J. Gies, consulting chemist of the Garden, has continued his weekly visits to the laboratories during the year to supervise the work of students carrying on investigations of problems in biological chemistry.

Insect Pests and Plant Diseases

The regular spraying work for insect pests with scalecide and whale-oil soap has been continued as usual. The equipment for this work has been extended by the addition of a spraying apparatus which will make it possible to reach trees to a height of fifty feet. In addition to the remedies mentioned above, arsenate of lead has been tried for biting insects. The elm trees were sprayed once as a preventative against the attacks of the elm leaf beetle. While it was too late in the season to secure the best results, the remedy seems to have been effective in destroying the insects and an earlier application of this remedy another year will doubtless yield very satisfactory results.

The chestnut disease is prevalent as usual and no remedy has been found for the disease. Numerous other fungous diseases have been noted during the year but none of sufficient importance to deserve special mention.

Morphological Grounds

In accordance with your request I have looked over the morphological grounds and noted additions which should be made in order to make these collections of living plants complete and in accordance with the original plans but no additions have yet been made. As originally planned, the plants in these grounds are arranged to illustrate the following:

1. Morphology and ecology of roots.
2. Morphology and ecology of leaves.
3. Morphology and ecology of thorns.
4. Climbing organs and modes of climbing.
5. Symbiosis other than parasitism.

Conference Meetings

As secretary of the conference of the scientific staff and students of the Garden, a programme has been arranged for the first Wednesday of each month during the academic year. These meetings are held in the library of the museum building. Seven meetings have been held during the year with a total attendance of 92 or an average attendance of 13 +. Some of the registered students who would attend these meetings are prevented from doing so on account of conflicting work at Columbia University.

The subjects treated during the year are: January 6, "Species of *Neomeris*," by Dr. M. A. Howe, "Mexican Mosses," by Mrs. N. L. Britton and Mr. R. S. Williams; February 3, "Review of Penhallow's Tertiary Plants of British Columbia," by Dr. Arthur Hollick, "Sex in Dioecious Plants," by Mr. C. A. Darling; March 3, "The Flora of Peribonca River, Quebec," by Dr. C. C. Curtis, "Notes on the Application of the Vienna Code of Nomenclature," by Dr. P. A. Rydberg; April 7, "Collecting in the Flathead Region, Montana," by Mr. B. T. Butler; May 5, "Botanical Supplies in the Public Schools of the City," by Dr. Arthur Hollick, "Report on Japanese Fungi," by Dr. W. A. Murrill, "Exhibition of a Specimen of *Stangeria*," by Mr. G. V. Nash; November 3, "Notes on Some Interesting Fungi," by Dr. W. A. Murrill and Mr. Fred J. Seaver, "Flora of the Cuban Keys," by Dr. N. L. Britton; December 1, "Relation of Organic Matter to Soil Fertility," by Mr. E. D. Clark, "Distribution of *Actinophyllum* in the West Indies," by Mr. R. C. Schneider. In addition to the regular outlined programmes numerous notes and discussions have been offered by various members of the staff. A synopsis of each of the papers and discussions brought out in these meetings has been published in the Garden JOURNAL.

Meteorological Records

Meteorological records have been kept as usual throughout the year. In order to make these records more permanent and to save time in looking up back records a new blank has been prepared of the proper size to be bound in book form at the close of each year. This blank provides space for a report of the condition of the weather for each day throughout the year as: "clear," "cloudy," "rain," etc., with the amount of precipitation for each day and total for the month, maximum and minimum temperatures and mean temperature for the month. The records have been kept in this form through the entire year and during the brief intervals of my own absence from the Garden the records have been made by Dr. W. A. Murrill.

Personal Investigations

My own investigations have been carried on in accordance with the plan outlined in previous report. In connection with culture work with the fungi, my attention has been called to the occurrence on heated soil of certain fungi which normally occur in nature on burnt ground. Investigations have shown that this is apparently due to some chemical change brought about in the soil by heat. One paper has been published on this subject: "Studies in Pyrophilous Fungi—I: The Occurrence and Cultivation of Pyronema."

Through the coöperation of Mr. E. D. Clark, of the department of biological chemistry, we have been able to gain much information as to the nature of the changes brought about in soil by heating and the problem is one which promises to have some practical bearing on questions of soil fertility as well as much scientific interest.

The main part of my investigation has been a taxonomic study of the fungi of the order Hypocreales. May 6 was spent in the Museum of Natural History of Philadelphia, special attention being given to the fungi of the Schweinitz Collection in that institution. Nineteen types were examined and with the permission of the authorities of the institution microscopic slides of the spores of these plants were prepared and become the property of the Garden. Three of the specimens desired were missing from the collection. In addition to the study of types, a more hasty examination of numerous other specimens was made.

August 5 was spent in the State Museum of New York at Albany, in the study of the types of various species of fungi described by Dr. C. H. Peck. With the permission of the authorities, microscopic slides of the various types were made as noted above. Fifteen types and several other specimens were studied in this manner. There are still a number of doubtful species in the order, most of which belong to the Berkeley and Curtis collection. It is probable that many of these may be studied at Cambridge.

A preliminary monograph of the order is being prepared in four parts. Two of these, "The Hypocreales of North America — I" and "The Hypocreales of North America — II," have been published in MYCOLOGIA and the third is now ready for printing. The material to constitute the fourth and last part of this preliminary monograph has been quite thoroughly worked over and this also will soon be published. It is the intention that the order Hypocreales and the small order Dothideales will together constitute part I of a volume for the "North American Flora" and it is probable that before the end of another year this will be completed.

In addition to those mentioned above, five other papers devoted to some phase of mycological work have been published.

In connection with the critical work on the ascomycetes and lower fungi, I have supervised the mounting of numerous specimens and notes belonging to this section of the mycological herbarium.

Students and Investigators

A total of 28 persons has carried on investigations at the Garden during the year, independently or in consultation with the various members of the staff, and for periods ranging from a few weeks to the entire year. In addition to this number numerous other individuals have visited the library and herbaria for the purpose of looking up smaller items of information, such persons not being included in the list of investigators.

Number of students and investigators registered.....	20
Investigators not registered....................	9
Total number of students and investigators.......	29

The following is a list of the students and investigators who have carried on work at the Garden during the year with a record of their academic training for research and the present or last position held:

*Anderson, Mary Perle. B.S., Mt. Holyoke, 90; Mass. Inst. Technology, 97-98; University of Chicago, 02-04; N. Y. Bot. Garden, 07-. Teacher of Nature Study, Horace Mann School, Teachers Coll., Columbia Univ.

Geographical distribution of the ferns of Japan.

†Andrews, Albert LeRoy. A.B., M.A., Harvard Univ; Ph.D., Kiel; Research scholar, N. Y. Bot. Garden, 09. Instructor in Cornell Univ.

Taxonomy of bryophytes.

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* Registered at Columbia.

† Research scholarship.

BARRETT, MARY FRANKLIN. B.L., Smith Coll., 01; A.M., Columbia Univ., 05; Woods Hole, 02; Cornell Univ. (summer school), 06; Columbia Univ. (various courses); N. Y. Bot. Garden 03-06, 09. Instructor in Nature Study, Montclair State Normal School, N. Jersey.

Taxonomy of fungi.

*BENEDICT, RALPH CURTISS. A.B., Syracuse Univ., 06; Aid, N. Y. Bot. Garden, 06-08; Fellow in Botany, Columbia Univ., 09-10. N. Y. Bot. Garden, 08-.

Taxonomy of ferns.

BOWER, FREDERIC ORPEN. Professor of Botany, Univ. of Glasgow. N. Y. Bot. Garden (Cinchona), summer, 09.

Ferns.

BRITTON, MRS. N. L. N. Y. City Normal Coll., 75; Hon. assistant instructor in Crypt. Botany, Columbia Univ., and Barnard Coll. and unpaid assistant in N. Y. Bot. Garden.

Anatomy and classification of mosses and ferns.
Mosses of the West Indies, southern Florida and Mexico.

BURLINGHAM, GERTRUDE SIMMONS. A.B., Syracuse Univ., 96; Ph.D., Columbia Univ., 08; N. Y. Bot. Garden, 05-. Teacher of Biology, Eastern District H. S., Brooklyn, N.Y.

Taxonomy of fungi.

*BUTLER, BERTRAM THEODORE. Ph.B., Hamlin Univ., 01; A.M., Columbia Univ., 08-09; N. Y. Bot. Garden, 07-. City Supt. of Schools and Teacher of Science, Glendive, Montana.

Flora of Montana.

*CANNON, GERTRUDE LOUISE. A.B., Barnard Coll.; A.M., 09; N. Y. Bot. Garden, summer, 09.

Cytology of flowering plants.

*CLARK, ERNEST DUNBAR. A.B. (in chemistry), Harvard Univ., 08; A.M., Columbia Univ., 09; John Harvard Scholar, Harvard Univ., 06-07; Assistant in Chemistry, Harvard Univ., 07-08; Research assistant to Professor Alsberg in Physiol. Chemistry, Harvard Medical School; Fellow in Physiol. Chemistry, Columbia Univ., 09-10.

Problems in plant chemistry.

COKER, WILLIAM CHAMBERS. B.S., S. Carolina, 94; Ph.D., Johns Hopkins Univ., 01; Bonn, 01-02; Cold Spring Harbor, 00; N. Y. Bot. Garden, 05, 07, 09; Professor of Botany, State Univ. of N. Carolina.

Flora of North Carolina.

*DARLING, CHESTER ARTHUR. A.B., Albion Coll., 04; A.M., 06; Ph.D., Columbia Univ., 09; N. Y. Bot. Garden, 06-. Assistant in Botany, Columbia Univ.

Cytology and plant physiology.

*DODGE, BERNARD OGILVIE. Ph.B., Univ. of Wisconsin, 09; Principal of H. S., Algoma, Wisconsin, 02-08. Assistant in Botany, Columbia Univ., 09-.

Mycology.

DURAND, ELIAS JUDAH. A.B., Cornell Univ., 93; Sc.D., 95; Research scholar, N. Y. Bot. Garden, 05. Instructor in Botany, Cornell Univ., 96-.

North American Discomycetes.

†EGGLESTON, WILLARD WEBSTER. B.S., Dartmouth, 91; Student, Gray Herbarium, 07; Biltmore Herbarium, 07-08; Aid, N. Y. Bot. Garden, 04-07; Research scholar, 08, 09.

Taxonomy of Pomaceae and Prunaceae.

*GRUENBERG, BENJAMIN CHARLES. B.S., State Univ. of Minn., 96; A.M., Columbia Univ., 04; N. Y. Univ., 01-02; N. Y. Bot. Garden, 02-06, 08-09. Teacher of Biology, DeWitt Clinton H. S., N. Y. City.

The mycorrhiza problem.

HAYNES, CAROLINE COVENTRY. N. Y. Bot. Garden, various times, 02-.

Taxonomy of bryophytes.

†HOWE, REGNALD HEBER, JR. Special student, Lawrence Science School, 97-01; M.S., Middlesex School, Concord, Mass., 01.

Taxonomy of lichens.

HUMPHREYS, EDWIN WILLIAM. A.B., Coll. of the City of New York, 03; A.M., Columbia Univ., 06; N. Y. Bot. Garden, 05-06 and voluntary assistant to Dr. Hollick. Teacher in the Elementary Schools of N. Y. City.

Paleobotany.

*MIDDLETON, FLORENCE. Teachers Coll., Columbia Univ., 00-. Teacher of Biology, Wadleigh H. S., N. Y. City.

Taxonomy of fungi.

MILLSPAUGH, CHARLES FREDERICK. M.D., N. Y. Homeop. Med. Coll., 81; N. Y. Bot. Garden, various times, 03-09; Student in various American and foreign herbaria. Curator, Dept. of Botany, Field Museum of Nat. Hist., Chicago.
Flora of the West Indies.

*ROBINSON, WINIFRED JOSEPHINE. B.S. and Ph.B., State Univ. of Michigan, 99; A.M., Columbia Univ., 04; Mich. State Normal Coll., 92; Mich. Agric. Coll., 94; Woods Hole, 99 and 00; N. Y. Bot. Garden, 02-03; Research scholar, 02-03; Laboratory Assistant, 07-08. Instructor in Biology, Vassar Coll., N. Y.
Taxonomy of ferns.

*SAGE, LILLIAN BELLE. A.B., Cornell Univ., 01; N. Y. Bot. Garden, 06-08. Teacher of Biology in Washington Irving H. S., N. Y. City.
Taxonomy of mosses.

*SCHWARZE, CARL ALOIS. B.S., Missouri State Univ., 09; Student assistant in Bot., Missouri State Univ., 08-09.
Mycology, pathology.

SHREVE, FORREST. A.B., Johns Hopkins Univ., 01; Ph.D., 05; Bruce Fellow, 05-06; N. Y. Bot. Garden (Cinchona), 05-06, 09.
Effect of moisture and altitude on plants.

SLOSSON, MARGARET. N. Y. Bot. Garden, 02–04, 09.
Taxonomy of ferns.

†SUMSTINE, DAVID ROSS. A.B., Thiel Coll.; M.S., Univ. of Pittsburg. Research scholar, N. Y. Bot. Garden, 09.
Taxonomy of fungi.

TAYLOR, ALEXANDRINA. Special student, Barnard Coll., Columbia Univ.; assistant, 90-95; N. Y. Bot. Garden, 00-.
Taxonomy of mosses.

*WILKINS, LEWANNA. B.S., Wellesley Coll., 01; Woods Hole (Wellesley Coll. Table), 96; C. Hart Merriam's Camp, California, summer, 98; Goettingen, Germany, spring and summer, 01; Chicago Univ. (summer school), 05; Columbia Univ. (summer school), 07; N. Y. Bot. Garden, 07, 08, 09. Teacher of Biology, Eastern District H. S., Washington, D. C.
Taxonomy of flowering plants.

Respectfully submitted,

F. J. SEAVER,
Director of the Laboratories.

REPORT OF THE LIBRARIAN

DR. N. L. BRITTON, DIRECTOR-IN-CHIEF.

Sir: I have the honor to submit the following report for the year 1909.

A census of the library, taken at the end of the year, shows 21,708 bound volumes, an apparent increase of 478 volumes since the last report. Successive censuses, being taken directly from the books upon the shelves, at intervals of a year, are liable to inconsistencies, owing to differences of opinion as to exactly what constitutes a "bound volume"; it is believed that a more conservative view of this question has been taken this year than heretofore, which will account at least in part for the small increase reported.

Among the year's accessions were 345 volumes (many, as usual, unbound); 152 pamphlets purchased on the account of the special book fund, and 61 volumes received as gifts; the principal accessions have been listed from time to time in the JOURNAL of the Garden, as heretofore. The number of volumes bound during the year is 353; of these, 87 are the property of Columbia University, on deposit at the Garden. At the time of writing this report there are 234 volumes at the bindery; these have not been included in the statistics of the library for 1909.

The appended list shows the serial publications received regularly by the Garden.

Respectfully submitted,
JOHN HENDLEY BARNHART,
Librarian.

LIST OF PERIODICALS

*Académie Internationale de Géographie Botanique, Le Mans, France. *Bulletin.*

Agricultural Experiment Station, Auburn, Ala.

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* Periodicals subscribed for by the Garden.

† Periodicals subscribed for by Columbia University and deposited at the Garden.

‡ Periodicals received in exchange by the Torrey Botanical Club and deposited at the Garden.

All others are received in exchange by the Garden.

Agricultural Experiment Station, Tuskegee, Ala.
“ “ “ Uniontown, Ala.
“ “ “ Tucson, Ariz.
“ “ “ Fayetteville, Ark.
“ “ “ Berkeley, Calif.
“ “ “ Fort Collins, Colo.
“ “ “ New Haven, Conn.
“ “ “ Storrs, Conn.
“ “ “ Newark, Del.
“ “ “ Gainesville, Fla.
“ “ “ Experiment, Ga.
“ “ “ Honolulu, Hawaii.
“ “ “ Moscow, Idaho.
“ “ “ Urbana, Ill.
“ “ “ Lafayette, Ind.
“ “ “ Ames, Iowa.
“ “ “ Manhattan, Kan.
“ “ “ Lexington, Ky.
“ “ “ Baton Rouge, La.
“ “ “ Orono, Me.
“ “ “ College Park, Md.
“ “ “ Amherst, Mass.
“ “ “ Agricultural College, Mich.
“ “ “ St. Anthony Park, St. Paul, Minn.
“ “ “ Agricultural College, Miss.
“ “ “ Columbia, Mo.
“ “ “ Bozeman, Mont.
“ “ “ Lincoln, Neb.
“ “ “ Reno, Nev.
“ “ “ Durham, N. H.
“ “ “ New Brunswick, N. J.
“ “ “ Mesilla Park, N. Mex.
“ “ “ Geneva, N. Y.
“ “ “ Ithaca, N. Y.
“ “ “ Raleigh, N. C.
“ “ “ Fargo, N. D.
“ “ “ Wooster, Ohio.
“ “ “ Stillwater, Okla.
“ “ “ Corvallis, Oregon.

Agricultural Experiment Station, State College, Pa.
“ “ “ Mayaguez, Porto Rico, W. I.
“ “ “ Kingston, R. I.
“ “ “ Clemson College, S. C.
“ “ “ Brookings, S. Dak.
“ “ “ Knoxville, Tenn.
“ “ “ College Station, Texas.
“ “ “ Logan, Utah.
“ “ “ Burlington, Vt.
“ “ “ Blacksburg, Va.
“ “ “ Morgantown, W. Va.
“ “ “ Pullman, Wash.
“ “ “ Madison, Wis.
“ “ “ Laramie, Wyo.
Agricultural Gazette of New South Wales, Sydney, N. S. W.
Agricultural Journal of India, Calcutta, India.
Agricultural Ledger, Calcutta, India.
Alabama. Geological Survey of Alabama, University, Ala. *Bulletin*, *Report*.
† Allgemeine Botanische Zeitschrift, Karlsruhe, Germany.
Alumni Journal, College of Pharmacy, New York, N. Y.
Amani. Biologisch-Landwirtschaftliches Institut, Bezirk Tanga, Deutsch-Ost-Afrika. *Berichte*.
America. Botanical Society of America. *Publications*.
America. Society of American Florists, Boston, Mass. *Proceedings*.
American Academy of Arts and Sciences, Boston, Mass. *Proceedings*.
American Agriculturist, New York, N. Y.
American Association for the Advancement of Science, Washington, D. C. *Proceedings*.
* American Botanist, Joliet, Ill.
American Florist, Chicago, Ill.
* American Homes and Gardens, New York, N. Y.
American Journal of Pharmacy, Philadelphia, Pa.
American Journal of Science, New Haven, Conn.
American Museum of Natural History, New York, N. Y. *Bulletin*, *Report*.
‡ American Naturalist, Boston, Mass.
American Philosophical Society, Philadelphia, Pa. *Proceedings*.

American Review of Tropical Agriculture, Mexico City, Mexico.
American Rose Society, New York, N. Y. *Bulletin.*
† Annales des Sciences Naturelles : Botanique ; Paris, France.
Annales Mycologici, Berlin, Germany.
Annali di Botanica ; see Rome, R. Instituto Botanico.
† Annals of Botany, London, England.
Antwerp. Jardin Botanique, Antwerp, Belgium. *Seed Lists.*
Appalachian Mountain Club, Boston, Mass. *Appalachia.*
Arboriculture : see International Society of Arboriculture.
* Archiv der Pharmazie, Berlin, Germany.
* Archiv für Zellforschung, Leipzig, Germany.
Ardennes. Société d'Histoire Naturelle, Charleville, France. *Bulletin.*
Argentine Republic. Museo de La Plata, Argentina. *Anales.*
Argentine Republic. Sociedad Cientifica Argentina, Buenos Aires, Argentina. *Anales.*
Arkiv für Botanik : see Sweden, Kongliga Svenska Vetenskaps-Akademien.
Asiatic Society of Bengal : see Bengal, Asiatic Society.
Asmara. Ufficio Agrario Sperimentale, Asmara, Colonia Eritrea, N. E. Africa. *L'Agricoltura Coloniale.*
* Association Française pour l'Avancement des Sciences, Paris, France. *Compte Rendu.*
Association pour la Protection des Plantes, Geneva, Switzerland. *Bulletin.*
Audubon Park: see New Orleans.
Augsburg. Naturwissenschaftlichen Vereins für Schwaben und Neuburg (a. V.) früherer Naturhistorischen Vereins in Augsburg, Augsburg, Germany. *Bericht.*
Bahama Islands. Agricultural Department, Nassau, N. P., Bahamas. *Bulletin.*
Bambou: see Le Bambou.
Basel. Naturforschende Gesellschaft, Basel, Switzerland. *Verhandlungen.*
Bavaria. Bayerische Gesellschaft zur Erforschung der Heimischen Flora, Munich, Bavaria. *Berichte*, *Mitteilungen.*
* Beiträge zur Wissenschaftlichen Botanik, Stuttgart, Germany.
Belgium. Société Royale de Botanique de Belgique, Brussels, Belgium. *Bulletin.*
Belgrade. Jardin Botanique "Jevremovac," Belgrade, Servia. *Seed Lists.*

Belize. Botanical Garden, Belize, British Honduras, Central America.

Bengal. Asiatic Society of Bengal, Calcutta, India. *Journal.*

Bergianska Trädgården, Stockholm, Sweden. *Acta Horti Bergiani.*

‡ Berlin. Königlicher Botanischer Garten, Berlin, Germany. *Notizblatt.*

Bermuda. Report of the Board of Agriculture, Bermuda, W. I.

Bernice Pauahi Bishop Museum, Honolulu, Hawaii.

† Bibliotheca Botanica, Stuttgart, Germany.

* Biltmore Botanical Studies, Biltmore, N. C.

* Biologisches Centralblatt, Leipzig, Germany.

* Biometrika, London, England.

Bombay. Victoria Gardens, Bombay, India. *Report.*

Boston. Board of Commissioners of Department of Parks, Jamaica Plain, Mass. *Annual Report.*

Boston. Board of Metropolitan Park Commissioners, Boston, Mass. *Report.*

‡ Boston Society of Natural History, Boston, Mass. *Proceedings.*

Botanical Gazette, Chicago, Ill.

† Botanical Magazine, London, England.

Botanical Society of America: see America, Botanical Society.

† Botanische Jahrbücher, Leipzig, Germany.

† Botanische Zeitung, Leipzig, Germany.

† Botanischer Jahresbericht, Leipzig, Germany.

† Botanisches Centralblatt, Cassel, Germany.

† Botanisches Centralblatt, Beihefte, Cassel, Germany.

‡ Botanisk Tidsskrift: see Copenhagen, Société Botanique.

Botaniste: see Le Botaniste.

‡ Botaniska Notiser, Lund, Sweden.

Brandenburg. Botanischer Verein der Provinz Brandenburg, Berlin, Germany. *Verhandlungen.*

Braunschweig. Herzoglicher Botanischer Garten, Brunswick, Germany. *Seed Lists.*

Bremen. Naturwissenschaftlicher Verein, Bremen, Germany. *Abhandlungen.*

* British Mycological Society, Worcester, England. *Transactions.*

Brooklyn Institute of Arts and Sciences, Brooklyn, N. Y. *Report, Memoirs of Natural Science, Science Bulletin, Museum News, Cold Spring Harbor Monographs.*

Broteria: Revista de Sciencias Naturaes do Collegio de S. Fiel, Lisbon, Portugal.

Brussels. Institut Botanique de l'Université, Brussels, Belgium. *Recueil.*

Brussels. Jardin Botanique de l'État, Brussels, Belgium. *Bulletin.*

* Bryologist, Brooklyn, N. Y.

Bucharest. Institut Botanique, Bucharest, Roumania, *Bulletin de l' Herbier.*

Budapest. Hortus Botanicus Universitatis Budapestinensis, Budapest, Hungary. *Seed Lists.*

Buenos Aires. Jardin Botanico Municipal de Buenos Aires, Buenos Aires, Argentine Republic. *Seed Lists.*

Buenos Aires. Museo de Farmacologia, Buenos Aires, Argentine Republic. *Trabajos.*

Buenos Aires. Museo Nacional, Buenos Aires, Argentine Republic. *Anales.*

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REPORT OF THE SUPERINTENDENT OF GROUNDS

Dr. N. L. Britton, Director-in-Chief.

Sir: I have the honor to submit the following report for the year 1909.

Construction of Paths, and Grading

After the partial completion of conservatory range no. 2 and its power house developments were taken up on the grounds east of the Bronx River. Regulating about these buildings was mostly completed, as far as practicable, before the grade of the Bronx Boulevard, now under construction, is finally established; the stone obtained by this excavation was used to pave new paths laid out about the range, and it remains to complete them with screenings. An approach for heavy truckage to the coal bunkers of this power house was constructed of concrete eight inches thick, and the path leading to it was prepared to be used as a temporary road for the delivery of coal; these paths as paved measure 475 feet in length.

The paths east and west of the main driveway from the Woodlawn Road approach to the Upper Bridge, partly under construction in 1908, and a path in almost a straight line from that point along the river to the bridge, and also a connecting path in the fruticetum, measuring 2,125 feet in length over all, were constructed and opened to the public. This path work was continued east of the Upper Bridge along the river road, a distance of 900 feet; the Telford foundation was laid and the work is now ready to be surfaced with screenings. From that point a path was laid out, leading in a westerly direction, crossing the Bronx River over a newly constructed temporary footbridge, and connecting with the path opposite the Woodlawn Road approach west of the river; a path was also laid out, beginning about 100 feet west of said bridge, leading in a northerly direction and connecting with the path leading north; these paths are all graded, line stones laid and a part of them paved or filled in with broken rock. They measure 1,100 feet.

Grading of the slope between the river road and the new path, about thirty-five feet in width, has been regulated, covered with twelve inches of top soil, borders sodded and the slope sown a distance of 500 feet in length; the surplus earth obtained from said slope and from the side hill east of the road, amounting to 2,211 cubic yards, was used to fill low portions of the meadows, and the top soil covering has been obtained from the grading of the new paths in this area.

Improvements of the paths west of the Boulder Bridge were carried east over the bridge, extended to the east and south, and connected with the existing path leading north, measuring 460 feet. North of the bridge the river has been widened to about seventy-five feet, and south of the bridge a cut was excavated twenty feet in width and 400 feet in length, to form an additional channel for the river, thus creating an island measuring about twenty feet in width.

Northeast of the bridge a lake was dug, measuring 175 by 50 feet and 3 feet in depth, and a land drain from the east connected with it; the earth obtained from these excavations amounting to 2,600 cubic yards. The top soil was used to grade the surrounding area and the earth to fill in a swampy pocket of the river south of the path. This whole area, measuring about 300 by 200 feet, was regulated, graded and planted in the autumn.

The path northwest of the museum building was extended about 300 feet, graded and line stones laid, and the curved slope near the driveway filled in and partly regulated and sodded.

Work on additional paths near the northeast corner of the Garden was progressing when the close of the season in December put a stop to it.

About 1,500 feet of existing paths have been recoated with screenings and rolled.

In all, 2,125 feet of path were built and opened, and 2,335 feet are under construction; the paths are respectively ten, eleven and twelve feet in width.

Construction of Roads

The approach to conservatory range no. 2, having been partly broken up by coal trucks, has been rescreened and rolled and is now in good condition.

A portion of the unfinished road extending to the southeastern corner of the Garden was partly paved, covered with trap rock, coated with screenings, and rolled in the spring; work on that driveway was resumed in December and is now progressing.

The low protection wall constructed of boulders along the bank of the river on the river road has been extended 150 feet.

The main driveways were covered with screenings in November by the Department of Parks.

Drainage

The drainage in connection with regulating and grading on the new improved grounds was carried out systematically.

We have constructed seven catch-basins and laid eighty-seven feet of drain tile, sixteen feet of three-inch, 300 feet of six-inch and fourteen feet of twenty-four-inch sewer pipe and constructed two culverts under paths.

About 3,000 feet of edging has been done along driveways, and grass gutters lowered and resodded, but there remains considerable work of this kind to be done.

Stone and Earth Excavated During the Year

	Cubic Yards.
Stone to new road east of the river	710
Stone from quarry behind museum building to paths	2,026
Line stones for paths	204

	Cubic Yards,
Earth excavation near Conservatories no. 2	540
Earth excavation of the river cut near Boulder Bridge and new lake	2,600
Earth removed and used for fill on the northeast meadows	2,211
Top soil removed from paths and used to grade northeast meadows	150
Earth removed from west boundary line to grade low grounds west of the road in north meadows	610
Minor excavations of earth and rock	500

Making a total of 9,551 cubic yards excavated and disposed of. With the exception of the excavations east of the Boulder Bridge and the fill west of the main road near the northern boundary line, hauls have all been of long distances.

Water Supply

The six-inch supply line reaching to the plaza near the stable has been extended 350 feet, crossing the old road and parallel with the new driveway; it was connected by two-inch galvanized pipe to the two-inch pipe supplying the propagating houses and the stable. One six-inch gate valve was set, and two hose-taps were connected at intervals of 250 feet.

The six-inch main along the westerly driveway to the fountains has been extended across the plaza of the New York Central and Hudson River Railroad Station along the westerly side of the west driveway to the plaza north of the lakes, where it was connected with the six-inch main leading to the fruticetum. One six-inch gate was inserted and eleven hose-taps have been connected. There was also one new drinking fountain connected at the crossing of the paths southwest of the west lake. The extension of six-inch pipe on both lines amounts to 1,944 feet.

Work Performed by Mechanics

The carpenters built twenty-three linear feet of herbarium cases; repaired the rustic benches, the doors of conservatories no. 1 and the stable and a number of door-checks through all buildings, and replaced several of the latter by new ones; built frame and door in subway, and a stairway in power house no. 2; repaired bottoms of wagons and carts, and a number of laborers' tools; built scaffolding for the painters when wanted and did other minor repairs in great variety.

The painters and glaziers painted, in conservatories no. 1, the lower portion of houses nos. 2, 3, 10 and 11, and at conservatories no. 2 the exterior of houses 1, 2 and 3, and at the propagating houses nos. 5 and 6; also painted shingled roof and sash of the potting house. In the museum building all galvanized iron work on central dome and flag poles, three rooms and hallway in basement, and two toilets have been painted, and the floor of the lecture hall oiled.

The entire exterior of the stable has been painted one coat. The iron fence on the southern boundary line has been touched up; a number of garden signs were renewed; wagons, carts, and all the agricultural machinery have been coated, and the general repairs and glazing during the year were attended to.

The blacksmith made all minor repairs on wagons, carts, machinery, and tools, and sharpened the steel drills used in the quarries.

In stone masonry we have built seven catch-basins and reconstructed of concrete, 1,050 square feet and eight inches in thickness, the approaches for coal delivery of the two power houses.

Stable, Horses and Vehicles

Only ordinary repairs were required in the stable; the stalls have been kept clean and the horses in a sanitary condition. The equipments are in good repair and one new cart and set of cart harness has been purchased. The vehicles and some of the agricultural machinery need minor repairs; they all will be painted before being used. An exceptional quantity of good hay was obtained from the meadows of the non-improved portions of the Garden last summer, but on November 12, at 8 P. M., the haystack was set on fire (maliciously, as it appears). The structure burned down and most of the fodder was destroyed; a small part of it can be used for bedding for the horses.

The expense for fodder and straw during the year amounted to $833.57; for horse shoeing $166.50.

Care of the Grounds

For maintenance of the existing Telford-Macadam roads, one sprinkling wagon and two laborers were detailed by the Department of Parks; the sprinkler could only water about one-fifth of the driveways within the Garden; it rarely reached any part north of the museum building. It was in use in July and August and up to September 10. The two men kept the roads in a fairly clean condition, but they were withdrawn about the fifteenth of September.

The great number of visitors during the summer months necessitated the construction of additional iron fences along paths, especially in the southern portion of the Garden, similar to those in other locations, to replace the wire fences constructed five years ago.

Violations of rules have not been as many as in previous years. Our special patrolman made five arrests, mostly drivers. A number of peddlers offering candies and cigars for sale had to be excluded from the grounds. In the first part of November about fifty labels were stolen from shrub beds in the fruticetum.

At the beginning of the summer successful efforts were made to reduce mosquito breeding. Swamps were filled in, drained, and kerosene oil used in catch-basins and drain pipes and on the shores of the lakes and marshy places.

Respectfully submitted,

F. A. Schilling,
Superintendent of Grounds.

SCHEDULE OF EXPENDITURES DURING THE YEAR 1909, UNDER APPROPRIATIONS

1. City Maintenance Account $79,520.00

Salaries and Wages

Appropriated	63,420.00
Expended	63,416.50
Balance	3.50

General Supplies

Appropriated	3,000.00
Expended	3,000.00

Materials for Repairs and Replacements by Departmental Labor

Appropriated	1,000.00
Expended	996.63
Balance	3.37

Repairs and Replacements by Contracts or Open Orders

Appropriated	500.00
Expended	498.50
Balance	1.50

Fuel

Appropriated		11,000.00
Expended through Park Department contracts for coal	9,645.00	
Expended by N. Y. Botanical Garden	1,341.57	10,986.57
Balance		13.43

Contingencies

Appropriated	500.00
Expended	499.79
Balance	.21

Telephone—Rental of

Appropriated		100.00	
Expended		94.37	
Balance		5.63	
Total expended			79,492.36
Balance			27.64

2. CONSTRUCTION AND EQUIPMENT

January 11, Balance		34,121.04	
July 13, New Appropriation		25,000.00	
Premium on Bonds		605.31	59,726.35
Expended, through Park Department, miscellaneous contracts	21,242.76		
Open market orders	3,319.89	24.562.65	
Expended, by New York Botanical Garden.			
Salaries and Labor	14,269.57		
Sundry expenses	93.00	14,362.57	
Total expended			38,925.22
			20,801.13
Less — Contract Liabilities	5,891.00		
Open market orders	109.25		6,000.25
Available balance			14,800.88

3. GARDEN ACCOUNTS

Museums and Herbarium

Appropriated	1,500.00	
Transferred from Investigations at other Institutions	150.00	
Transferred from Laboratories	205.00	
Transferred from Photography	120.00	
Transferred from Contribution to Maintenance, Laborers and Gardeners	30.00	2,005.00
Expended		2,004.59
Balance		.41

Library

Appropriated	1,000.00	
Transferred from Purchase of Plants	55.00	
Transferred from Laboratories	35.00	
Refund—Overpayment on Voucher	2.00	1,092.00
Expended		1,089.43
Balance		2.57

Laboratories

Appropriated		600.00	
Refund—Overcharge on Money Order		.37	600.37
Expended	63.70		
Expended for account Tropical Laboratory	293.52	357.22	
Transferred to Library		35.00	
Transferred to Museums and Herbarium		205.00	597.22
Balance			3.15

Publications. (Income of Lydig Fund)

Appropriated	3,500.00	
Subscriptions to "North American Flora"	671.87	
Sales of Publications	990.50	5,162.37
Expended		5,515.53
Shortage		353.16

Lectures and Lantern Slides

Appropriated		800.00
Expended	751.52	
Transferred to Exploration and Collecting	45.00	796.52
Balance		3.48

Horticultural Prizes

Appropriated		200.00
Expended	171.93	
Transferred to Circulars for Membership	5.00	
Transferred to Contingent Fund	15.00	191.93
Balance		8.07

Investigations at other Institutions

Appropriated	200.00	
Transferred from Contribution to Maintenance — Laborers and Gardeners	450.00	650.00
Expended	465.01	
Transferred to Circulars for Membership	25.00	
Transferred to Museums and Herbarium	150.00	640.01
Balance		9.99

Exploration and Collecting

Appropriated	2,000.00	
Transferred from Insurance	30.00	
Transferred from Lectures and Lantern Slides	45.00	
Transferred from Purchase of Plants	25.00	2,100.00
Expended		2,098.60
Balance		1.40

Research Scholarships

Appropriated	300.00
Expended	300.00

Expenses of Consulting Chemist

Appropriated	300.00
Expended	300.00

Photography

Appropriated		300.00
Expended	178.40	
Transferred to Museums and Herbarium	120.00	298.40
Balance		1.60

Preservation of Native Plants. (Income of Stokes Fund)

Appropriated	100.00
Expended	100.00

Aid for Students Research. (Income of Students Research Fund)

Appropriated	100.00
Expended	100.00

CONTRIBUTION TO MAINTENANCE—TO SUPPLEMENT CITY APPROPRIATION

Laborers and Gardeners

Appropriated		9,960.00
Expended	6,860.13	
Transferred to Investigations at other Institutions	450.00	
Transferred to Museums and Herbarium	30.00	
Inter-transfer to Supply Account	1,619.87	
Inter-transfer to Special Assistance	1,000.00	9,960.00

Supplies

Appropriated	1,500.00	
Refund—Repayment of Gas claim	57.56	
Inter-transfer from Laborers and Gardeners	1,619.87	
Inter-transfer from Special Assistance	149.01	3,326.44
Expended		3,326.31
Balance		.13

Additions to Salaries

Appropriated	1,020.00
Expended	1,020.00

Special Assistance

Appropriated	1,000.00	
Inter-transfer from Gardeners and Laborers	1,000.00	2,000.00
Expended	1,850.99	
Inter-transfer to Supply Account	149.01	2,000.00

Total Appropriated	13,480.00	
Refund	57.56	13,537.56
Total Expended	13,057.43	
Transferred to other Garden Accounts	480.00	13,537.43
Balance		.13

Salary of Secretary

Appropriated		1,500.00
Expended		1,500.00

Contingent Fund

Appropriated	1,000.00	
Transferred from Horticultural Prizes	15.00	1,015.00
Expended		1,013.77
Balance		1.23

Purchase of Plants

Appropriated		200.00
Expended	115.22	
Transferred to Exploration and Collecting	25.00	
Transferred to Library	55.00	195.22
Balance		4.78

Circulars for Membership

Appropriated	200.00	
Transferred from Investigations at other Institutions	25.00	
Transferred from Horticultural Prizes	5.00	230.00
Expended		227.27
Balance		2.73

Insurance

Appropriated	450.00	
Refund—Insurance Premium overpaid	.85	450.85
Expended	418.26	
Transferred to Exploration and Collecting	30.00	448.26
Balance		2.59

Assistance for Treasurer

Appropriated		180.00
Expended		180.00

Total Appropriated for Garden Accounts	27,910.00	
Subscriptions to "North American Flora"	671.87	
Sales of Publications	990.50	
Refunds	60.78	29,633.15
Total Expended for Garden Accounts		29,944.18
Shortage		311.03

4. SPECIAL GARDEN ACCOUNTS

Conservatory Fund

Subscribed 1900	2,110.00	
Subscribed 1901	25.00	
Refund—Balance on Draft	15.27	
Subscribed 1902	486.55	
Refund—Unexpended Balance	9.70	
Subscribed 1903	200.00	
Sale of duplicate palms	100.00	
Sale of plants	78.00	
Sale of palms 1904	125.00	
Subscribed 1908	260.00	
Subscribed 1909	550.00	3,959.52
Expended 1900	710.44	
Expended 1901	1,437.42	
Expended 1902	404.41	
Expended 1903	447.66	
Expended 1904	121.21	
Expended 1908	245.65	
Expended 1909	133.28	3,500.07
Balance		459.45

Exploration Fund

Subscribed 1901	2,050.00
Refund—Balance on Draft	87.59
Subscribed 1902	2,130.00
Refund—Unexpended Balance	180.56
Subscribed 1903	1,565.00
Refunds—Unexpended Balances	275.11
Subscribed 1904	3,183.45
Refunds—Unexpended Balances	110.50
Subscribed 1905	2,575.00
Sale of duplicate palms	100.00
Refunds—part of expenses—Exploration to the Bahamas	125.00
Subscribed 1906	1,050.00
Subscribed 1907	2,510.00
Refunds	529.84
Subscribed 1908	3,930.00

Refund—Unexpended Balance	14.49	
Subscribed 1909	4,410.00	
Refund—Unexpended Balance	60.20	24,886.74
Expended 1901	2,130.95	
Expended 1902	1,258.32	
Expended 1903	2,880.72	
Expended 1904	2,878.28	
Expended 1905	3,003.37	
Expended 1906	1,027.25	
Expended 1907	2,274.84	
Expended 1908	3,912.13	
Expended 1909	5,091.22	24,457.08
Balance		429.66

Museum and Herbarium Fund

Subscribed 1901	1,800.00	
Subscribed 1902	655.00	
Refund (advance charge on specimens account of R. S. Williams)	131.09	
Subscribed 1903	1,405.00	
Sale of specimens	29.50	
Subscribed 1904	100.00	
Subscribed 1906	2,550.00	
Subscribed 1908	1,575.00	
Subscribed 1909	200.00	8,445.59
Expended 1901	1,546.19	
Expended 1902	1,024.96	
Expended 1903	1,437.63	
Expended 1904	100.00	
Expended 1906	2,224.57	
Expended 1907	250.00	
Expended 1908	1,646.80	
Expended 1909	177.11	8,407.26
Balance		38.33

Special Book Fund

Subscribed 1899	4,950.00	
Subscribed 1901	1,825.00	
Subscribed 1902	2,265.00	

Subscribed 1903	1,315.00	
Special contribution from Mr. Andrew Carnegie	1,997.88	
Sale of books	59.60	
Refunded—Balance on Drafts	20.93	
Subscribed 1904	1,540.00	
Sale of duplicate books	15.15	
Subscribed 1905	2,175.00	
Sale of duplicate books	25.50	
Subscribed 1906	310.00	
Subscribed 1907	100.00	
Subscribed 1908	3,130.00	
Subscribed 1909	1,850.00	21,579.06
Expended 1899	1,916.65	
Expended 1900	2,395.28	
Expended 1901	2,463.02	
Expended 1902	2,256.25	
Expended 1903	3,397.75	
Expended 1904	1,031.92	
Expended 1905	2,178.99	
Expended 1906	748.29	
Expended 1907	195.28	
Expended 1908	2,760.36	
Expended 1909	716.66	20,060.45
Balance		1,518.61

Hudson-Fulton Celebration Fund

Special Contributions 1909	999.80
Expended 1909	999.80
Total expended from Funds of the Garden.	37,062.25

WALTER S. GROESBECK,
Accountant.

E. & O. E.
NEW YORK, January 10, 1910.

REPORT OF THE CHAIRMAN OF THE SCIENTIFIC DIRECTORS FOR THE YEAR 1908*

To the Board of Managers of the New York Botanical Garden.

Gentlemen: The past year has been a memorable one in the history of the scientific work of the Garden, chiefly because of changes rendered necessary as the result of the death of Professor Underwood, and the resignation of Dr. Gager, both of which events have been announced to you in special reports. Toward the close of the year it seemed for a time as though death would claim our learned and talented Librarian also, but this great calamity has happily been averted.

Not only have the changes referred to deprived us of the services of two most valuable officers, but they have indirectly led to rather important modifications in the character of the research work being here performed. It is always a matter of difficulty to replace a worker of such ability and activity as Professor Underwood by another who is devoted to exactly the same line of research. In the present instance we have not as yet found it possible to make any definite arrangement for continuing Professor Underwood's work upon the ferns. A step in this direction has, however, been taken in arranging for a few weeks' work on special subjects, upon the Underwood Fern Herbarium, by Mr. W. R. Maxon, of the U. S. National Museum.

A further partial provision for continuing the general line of cryptogamic investigation that occupied Professor Underwood was made in the selection of Dr. Fred J. Seaver as the successor of Dr. Gager. Dr. Seaver, as an accomplished student of plant pathology, is necessarily at home in the field of cryptogamic botany. Since a knowledge of plant diseases must rest upon that of plant physiology, we have really combined in our present Director of the Laboratories a representation of the general lines of work pursued by both Dr. Underwood and Dr. Gager.

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*Presented and ordered printed in the Bulletin May 8, 1909.

This new arrangement is specially satisfactory to our Assistant Director, whose researches in mycology become more and more interrupted by his administrative duties, and who is often very glad to utilize the services of so excellent a mycologist as Dr. Seaver.

Next in importance to these rearrangements was probably the authorization to establish a new Garden publication, namely, MYCOLOGIA. Although essentially a new publication, MYCOLOGIA may be regarded as a successor to the *Journal of Mycology*, a large part of the subscription list of which will come to the new publication. In the symmetrical development of botanical science in America, there exists a positive necessity for such a publication, and its inauguration represents one of the important functions of the Garden. It is very fortunate that just at this time, we should have found it possible to utilize a new cheap process for the production of colored plates, so highly important in the illustration of fungi.

The other publications of the Garden have appeared regularly. Three parts of "North American Flora," aggregating 255 pages, have been issued.

Dr. Gager's paper on the effects of the rays of radium on plants, comprising Volume 4 of the MEMOIRS, takes rank among the great contributions to the subject of vegetable physiology.

Although not published under the auspices of the Garden, two publications of an encyclopedic character should receive mention here, because of the important part which the collections and library of the Garden have taken in contributing to their success. The first is Dr. Britton's Manual of the Trees of North America; the other is the second edition of the National Standard Dispensatory.

The explorations of the year have been conducted in conformity with the plan adopted by the Scientific Directors three years ago, namely, that of systematically investigating the floras of definite regions. Dr. Britton has conducted two explorations in Jamaica, on one of which he was accompanied by Mrs. Britton and Dr. Hollick.

Mr. Williams has visited a little known part of the State of Panama.

Dr. Murrill devoted a number of weeks to the study and collection of fungi in North Carolina.

Although not conducted under the auspices of the Garden, an exploration of the Mexican rubber forests by myself has proved of considerable interest to us.

The additions to our collections and library have been extensive and important and are discussed in detail in separate reports by the heads of the respective departments. The same is also true of the research work conducted in our laboratories, the spring and fall lecture courses, and the lectures to school children.

My predecessor, in his report for 1904, called attention to the need of increased endowment for the maintenance of our scientific work, and special instances of this need have from time to time been set forth in succeeding reports. I venture to direct your attention to the fact that this need will necessarily become more urgent with each succeeding year. While the demands for construction work are heaviest in the earlier years of such an institution, the reverse is true of those for maintenance. A steady increase in the number of living plants, and in the intensity of cultivation, is an essential feature of the development of a botanical garden. Not only does the cost of maintenance increase proportionally therewith, but in many instances the care increases with the growth of the plants already under cultivation. At no time in the Garden's history has its scientific staff received a compensation in conformity with either their services or with that paid in similar institutions elsewhere, and a policy of over-work and under-pay cannot possibly conduce to the welfare of any institution the success of which depends so directly upon the services of its official staff. Instead of becoming better in this particular, the position of the Garden is becoming distinctly worse, since it is indisputable that our needs are increasing much more rapidly than our income. While it is obligatory upon the city to provide funds for our maintenance, the amount of such appropriations is optional with it, and the immediate outlook is not promising for the supply of our positive needs. It is, in my opinion, urgently necessary that the Scientific Directors should in the early future devise plans for the increase of our endowment, in accordance with the actions taken at the annual meeting, January 9, 1905, and on May 9, 1907, at which latter time a statement of the needs of the Garden was authorized, and published in its JOURNAL for that month. If our endowment could be increased to $1,000,000, as then recommended, our needs would be met.

Respectfully submitted,
H. H. RUSBY,
Chairman.

REPORT OF THE CHAIRMAN OF THE SCIENTIFIC DIRECTORS FOR THE YEAR 1909

(*Presented and ordered printed January* 10, 1910)

TO THE BOARD OF MANAGERS OF THE NEW YORK BOTANICAL GARDEN.

Gentlemen: The meetings of the Scientific Directors have been held regularly during the year 1909, on April 10, June 12, October 9 and December 21. At each meeting steady progress in the development of all lines of the Garden's work has been recorded. The details of this work are incorporated in the annual reports of the heads of the several departments. The present report is confined to the purposes of a general review.

In the matter of publications the most gratifying feature is the steady advance toward a condition of self-support, indicating that, on the basis of our present expenditure, our scientific publications will in the near future cease to be a source of net expense to us. Interest in this fact relates chiefly to the increased public interest that is indicated by the larger number of subscribers, and to the consequent extension of our educational influence.

In our work of exploration we have steadily pursued the plan adopted in 1907, at the suggestion of my predecessor, so far as conditions would permit. Probably the most important work of this kind since then has been conducted in the Bahamas, with the result that there now remains but one undertaking to complete our exploration of these islands, and to permit the publication of their flora. This is the exploration of the interior of the Island of Andros, which will be undertaken by Dr. Small during 1910. Explorations in Cuba have been pursued by Mr. Shafer; in Florida by Dr. Small; in Santo Domingo by Mr. Taylor; in the southern United States by Mr. Eggleston, and in Jamaica by Dr. Murrill, the latter with special reference to the fleshy fungi. Work in the same direction is now in progress by Dr. Murrill, in Mexico, and by Dr. Howe, with special reference to Algae, in Panama. Dr. Britton and Mr. Shafer will continue work in Cuba this year.

Our herbarium and museum collections have been greatly enriched by these explorations, and it is worthy of note that these collections have in nearly all cases been promptly studied and determined. One of the most common shortcomings in herbaria is the accumulation of large amounts of unstudied material, an evil which we have to a great extent found it possible to avoid. For the purpose of some critical work in the furtherance of this object, Dr. Britton spent some time at Kew and the British Museum, during August and September.

The economic museum has been enriched by very considerable collections, chiefly of drugs and fleshy fruits, collected by the Chairman in many states of the Union. It is proposed to continue this work during the coming year in Mexico. While the special value of these collections is economic, the possession of such a class of material, in formalin, is incidentally found to be of no little value in scientific study. The study of the economic material collected for us by Messrs. Weiss and Schmidt in northern Brazil has been found to consist almost wholly of species not previously represented in either our museum or herbarium.

Considerable work of importance has been done in the study of our local flora, comprising the territory within a radius of one hundred miles. It is felt that, owing to the rapid extension of building operations, our records of this flora must be completed promptly, if it is to be done at all.

In this connection, we should note the segregation, in two separate cases, of our collections of fossil plants of New York and vicinity, as part of the general rearrangement of our paleobotanical museum. One of the most important publications of the year has been the report of Messrs. Hollick and Jeffrey, on the morphology of Cretaceous plants, based upon specimens collected on Staten Island.

An important addition to the fossil plant collections made during the year is the Vreeland collection from Florissant, Colorado.

The student work of the year has been varied and satisfactory. Some of the more important subjects are "The Mosses of the West Indies, Mexico and Southern Florida," "The Geographical Distribution of Ferns in Japan," "The Cytology of Flowering Plants," "Problems in Biological Chemistry," "The Mycorhiza Problem and the Effects of Moisture and Altitude on Plants."

The permanent employment of an artist to prepare plant models for our museum has been thoroughly discussed by the directors. While the great importance of having such a person upon our staff is recognized, it is not deemed expedient at the present time to appropriate the money necessary for the purpose.

In conclusion, we may say, in general, that we have considered it best to devote the coming year chiefly to the undertakings now under way, refraining from extensive new development, so as to permit the reimbursing of our permanent fund for moneys borrowed therefrom, as will be specifically explained by the Director-in-Chief.

Respectfully submitted,
H. H. RUSBY,
Chairman.

REPORT OF THE COMMITTEE ON PATRONS, FELLOWS AND MEMBERS FOR THE YEAR 1909

To the Board of Managers of the New York Botanical Garden.

Gentlemen: The number of new members who have qualified during the past year is 18. The number of annual members is now 838; life members 157; sustaining members 24; fellowship members 6.

Of these 31 are now in arrears for dues for 1909, 19 are in arrears for 1908 and 1909, 5 are in arrears for 1907, 1908 and 1909, and 5 are in arrears for 1906, 1907, 1908 and 1909.

Dues have been collected to the amount of $9,260 which has been transmitted to the Treasurer as received.

One person has qualified as a life member by the payment of $250. This sum has been transmitted to the Treasurer for credit to the Endowment Fund.

A complete list of all classes of members to date is herewith submitted.

New York, January 10, 1910.

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Geo. L. McAlpin,
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Mrs. W. H. McCord,
John A. McKim,
James McLean,
Geo. R. MacDougall,
Clarence H. Mackay,
Kenneth K. Mackenzie,
Malcoln MacMartin,
George H. Macy,

V. Everit Macy,
F. Robert Mager,
J. H. Maghee,
Pierre Mali,
Chas. Mallory,
Chas. E. Manierre,
Howard Mansfield,
Miss Delia W. Marble,
John Markle,
Dr. J. W. Markoe,
Henry S. Marlor,
C. P. Marsh,
Chas. H. Marshall,
Edwin S. Marston,
W. R. H. Martin,
Francis Taylor Maxwell,
Robert Maxwell,
David Mayer,
Harry Mayer,
Effingham Maynard,
D. J. Medbury,
Mrs. Emma Mehler,
Herman A. Metz,
Dr. Alfred Meyer,
Edwin O. Meyer,
Harry J. Meyer,
Geo. M. Miller,
Wilhelm Miller,
S. M. Milliken,
Alphonse Montant,
Chas. Arthur Moore, Jr.,
J. C. Moore,
Wm. H. Helme Moore,
Miss Anne T. Morgan,
Miss C. L. Morgan,
E. D. Morgan,
Geo. H. Morgan,
A. Newbold Morris,
Mrs. A. Newbold Morris,
Mrs. Cora Morris,
Mrs. Dave Hennen Morris,
Henry Lewis Morris,
John Morris,
Louis R. Morris,
Geo. Austin Morrison,
Richard Mortimer,
Henry C. Mott,
Carl Muller,
John P. Munn,
Frank A. Munsey,
J. G. Myers,
A. G. Nesbit,
Miss Catherine A. Newbold,
Miss Edith Newbold,
Frederic R. Newbold,
H. Victor Newcomb,
Zenas E. Newell,
Wm. Nilsson,
Adolph S. Ochs,
Robert C. Ogden,
E. E. Olcott,
Robert Olyphant,
Mrs. Emerson Opdycke,
Wm. S. Opdyke,
Mrs. Wm. Openhym,
William C. Orr,
Prof. Henry F. Osborne,
Augustus G. Paine,
S. S. Palmer,
Henry Parish, Jr.,
Mrs. Henrietta M. Parker,
James C. Parrish,
Chas W. Parsons,
Mrs. Edwin Parsons,
John E. Parsons,
R. W. Paterson,
W. A. Paton,
O. H. Payne,
T. W. Pearsall,
Mrs. Frederick Pearson,

Stephen H. P. Pell,
Chas. G. Peters,
Samuel T. Peters,
W. R. Peters,
Chas. Pfizer, Jr.,
Guy Phillips,
Lloyd Phoenix,
Phillips Phoenix,
Gottfried Piel,
Michael Piel,
Henry Clay Pierce,
Winslow S. Pierce,
Gifford Pinchot,
Fred. S. Pinkus,
Albert Plant,
Hon. Thos. C. Platt,
Gilbert M. Plympton,
Chas. Lane Poor,
Abram S. Post,
Miss Blanche Potter,
Frederick Potter,
Geo. H. Proctor,
Chas. Pryer,
J. Harsen Purdy,
Percy R. Pyne,
Dr. Edward Quintard,
Charles Raht,
Gustav Ramsperger,
Edmund D. Randolph,
S. Rawitser,
G. B. Raymond,
Geo. R. Read,
Wm. A. Read,
Miss Emily Redmond,
Geraldyn Redmond,
Henry S. Redmond,
Hon. Whitelaw Reid,
Geo. N. Reinhardt,
W. E. Reis,
E. B. Reynolds,
Miss Serena Rhinelander,
Samuel Riker,
Wm. J. Riker,
H. Dillon Ripley,
Dr. Wm. C. Rives,
Geo. I. Roberts,
Miss Mary M. Roberts,
Miss Jennette Robertson,
Julius Robertson,
Andrew J. Robinson,
Henry J. Robinson,
M. Rock,
Gen. Chas. F. Roe,
Edward L. Rogers,
W. Emlen Roosevelt,
Mrs. W. Emlen Roosevelt,
Hon. Elihu Root,
E. V. W. Rossiter,
Jacob Rothschild,
Ludwig Rothschild,
Wm. Rothschild,
Carman R. Runyon,
Jacob Ruppert,
Edward Russ,
Mrs. A. D. Russell,
Arthur Ryle,
Clarence Sackett,
Mrs. Russell Sage,
Daniel C. Sands,
Miss G. W. Sargent,
Dr. A. T. Schauffler,
Carl Schefer,
Miss Mary E. Schell,
Mrs. H. M. Schieffelin,
Dr. Wm. J. Schieffelin,
Gustave Schirmer,
Rudolph E. Schirmer,
Henry W Schloss,
Miss Jane E. Schmelzel,
D. Schnakenberg,

C. M. Schwab,
Henry F. Schwarz,
Geo. S. Scott,
Robert Scoville,
Arthur H. Scribner,
Edward M. Scudder,
Charles E. Seitz,
Prof. Edwin R. A. Seligman,
Geo. W. Seligman,
Jefferson Seligman,
E. W. Sells,
Alfred Seton,
Edward M. Shepard,
Arthur M. Sherwood,
Wm. Shillaber,
John W. Simpson,
Francis Louis Slade,
Albert K. Smiley,
Daniel Smiley,
Chas. F. Smillie,
Dr. A. Alexander Smith,
Mrs. Annie Morrill Smith,
F. M. Smith,
Mrs. Geo. W. Smith,
H. Sanborn Smith,
James R. Smith,
Sydney A. Smith,
Wm. Alex. Smith,
Samuel B. Snook,
E. G. Snow,
Leopold Solomon,
E. G. Soltmann,
Mrs. Charlotte Sorchan,
Joseph Spektorsky,
W. M. Sperry,
I. M. Spiegelberg,
Paul N. Spofford,
Miss Anna Riker Spring,
J. R. Stanton,
James H. Stebbins,
James R. Steers,
Chas. H. Steinway,
Wm. R. Steinway,
Olin J. Stephens,
Benjamin Stern,
Isaac Stern,
Louis Stern,
Alexander H. Stevens,
Frederic W. Stevens,
Dr. Geo. T. Stevens,
Lispenard Stewart,
Wm. R. Stewart,
Miss Clara F. Stillman,
Dr. D. M. Stimson,
James Stokes,
Sumner R. Stone,
Mrs. Marion Story,
Chas. Strauss,
Frederick Strauss,
F. K. Sturgis,
Mrs. F. K. Sturgis,
Rutherford Stuyvesant,
Mrs. Geo. Such,
Mrs. James Sullivan,
Miss P. C. Swords,
Miss Mary Taber,
Edward N. Tailer,
James Talcott,
C. A. Tatum,
Miss Alexandrina Taylor,
George Taylor,
Henry R. Taylor,
Stevenson Taylor,
C. H. Tenney,
H. L. Terrell,
Jno. T. Terry,
Thomas Thacher,
Ernst Thalmann,
Benjamin Thaw,
Miss M. J. Thayer,

Geo. C. Thomas,
Seth E. Thomas,
David W. Thompson,
L. S. Thompson,
Dr. W. Gilman Thompson,
Jonathan Thorne,
Samuel Thorne, Jr.,
W. V. S. Thorne,
Louis C. Tiffany,
Frank Tilford,
James Timpson,
J. Kennedy Tod,
William Tousey,
Miss Amy Townsend,
C. D. Tows,
Frederick K. Trowbridge,
Dr. Alfred Tuckerman,
Paul Tuckerman,
Geo. E. Turnure,
Benjamin Tuska,
Mrs. Eliza L. D. Tysen,
E. S. Ullman,
Mrs. Lawsen Valentine,
Augustus Van Cortlandt,
Alfred G. Vanderbilt,
Frank Vincent,
D. B. Van Emburgh,
E. H. Van Ingen,
Theodore Van Norden,
W. Van Norden,
Edgar B. Van Winkle,
Robert A. Van Wyck,
Richard C. Veit,
Herman Vogel,
John Wagner,
Richard T. Wainwright,
Wm. I. Walter,
Artemus Ward,
Wm. T. Wardwell,
E. H. Weatherbee,
Mrs. John A. Weekes,
Chas. Wehrhane,
Camille Weidenfeld,
Mrs. Samuel W. Weiss,
Charles W. Wells,
Mrs. John Wells,
Mrs. Robert E. Westcott,
Geo. Westinghouse,
Mrs. Alice T. Wheelock,
Dr. Wm. E. Wheelock,
Miss Caroline White,
Horace White,
John J. White, Jr.,
Miss Gertrude Whiting,
Giles Whiting,
Clarence Whitman,
Miss Margaret S. Whitney,
Wm. Wicke,
Edward A. Wickes,
D. O. Wickham,
Blair S. Williams,
Mrs. I. T. Williams,
Mrs. Percy H. Williams,
Richard H. Williams,
W. P. Willis,
Charles T. Wills,
George T. Wilson,
Henry R. Wilson,
Miss Margaret B. Wilson,
R. T. Wilson,
Egerton Winthrop,
Grenville L. Winthrop,
Mrs. Frank S. Witherbee,
Ernst G. W. Woerz,
Emil Wolff,
Lewis S. Wolff,
Mrs. Cynthia A. Wood,
Henry R. Wood,
James Wood,
Jas. T. Woodward,

Prof. R. S. Woodward,
W. H. Woolverton,
P. B. Worrall,
Miss Julia Wray,
Mrs. J. Hood Wright,
A. Wurzburger,
Jno. J. Wysong,
Edw. L. Young,
Andrew C. Zabriskie,
August Zinsser,
Charles Zoller,
O. F. Zollikoffer.

REPORT OF THE TREASURER

New York, January 10, 1910.

To the Board of Managers of the New York Botanical Garden.

Gentlemen: Herewith I submit a statement of my Receipts and Disbursements during the year 1909 and a Balance Sheet from my ledger as of December 31, 1909.

Respectfully yours,

C. F. Cox,
Treasurer.

Receipts

Balance as per last Annual Report......		$ 12,590.40
Contributions of the City towards Development and Maintenance.......		86,016.26
Income from Investments:		
5 per cent. on $50,000 Southern Railway Co. First Consolidated Mtge. Bonds..................	$ 2,500.00	
4.5 per cent. on $50,000 Ches. & Ohio R. R. Co. General Mtge. Bonds........................	2,250.00	
4 per cent. on $50,000 Erie R. R. Co. Prior Lien Bonds...........	2,000.00	
4 per cent. on $59,000 Erie R. R. Co. Penn. Collat. Trust Bonds ...	2,360.00	
4 per cent. on $50,000 Reading R. R. Co. Jersey Central Collat. Trust Bonds..................	2,000.00	
4 per cent. on $24,000 Northern Pacific R. R. Co. St. Paul & Duluth Division Bonds..........	960.00	
4 per cent. on $30,000 Northern Pacific-Gt. Northern, C. B. & Q. Collat. Trust Bonds.......... ...	1,200.00	13,270.00

Legacy of Wm. R. Sands, credited Endowment Fund		10,000.00
Annual Dues		8,075.00
Interest at 3 per cent. on balances on deposit with J. P. Morgan & Company		441.68
Proceeds Sales of Merchandise		82.30
Proceeds Sales of Publications		21.74
Life Membership Fees		250.00
Fellowship Members Fees		600.00
Sustaining Members Fees		575.00
Tuition Fees credited to Students' Research Fund		75.00
Subscriptions to "North American Flora" and sales of Publications, credited to Income of David Lydig Fund		1,643.87
Contributions to special Book Fund		1,890.00
Contributions to Exploration Fund		4,410.00
Contributions to Conservatory Fund		560.00
Contributions to Museum and Herbarium Fund		200.00
Contributions to Hudson-Fulton Celebration Fund		999.80
		$141,701.05

Disbursements

Expenses paid through Director-in-Chief account City Appropriations	86,016.26	
On General account for vouchers paid	19,187.64	
	$105,203.90	
Purchase account Museum and Herbarium Fund	672.60	
Books, account Special Book Fund	1,166.36	
Specimens, etc., account Exploration Fund	6,143.25	
Grants, account Students' Research Fund	100.00	
Publications, account Income of David Lydig Fund	4,333.88	

Grants, account Stokes Fund	100.00	
Purchase of Plants, account Conservatory Fund	287.08	
Disbursements, account Hudson-Fulton Celebration Fund	999.80	119,006.87
Balance, Cash in hands of Treasurer		$ 22,694.18

Ledger Balances, December 31, 1909

Credit

Permanent Funds:		
Endowment Fund	$281,160.00	
Fellowship Fees	11,000.00	
Life Membership Fees	19,500.00	
Students' Research Fund	2,869.50	
David Lydig Fund—Bequest of Chas. P. Daly	34,149.86	
Stokes Fund	3,000.00	
Temporary Funds:		
Special Book Fund, for Library	1,853.31	
Conservatory Fund, for Plants	459.45	
Exploration Fund	514.13	
Museum and Herbarium Fund, for Specimens	38.33	
Income Students' Research Fund	356.19	
Income Stokes Fund	299.13	$355,199.90

Debit

Investments:		
Net Cost of $50,000 Ches. & Ohio Ry. Co. Genl. Mtge. Bonds.	$302,611.68	
$50,000 Southern Ry. Co. 1st Consol. Mtge. Bonds.....		
$50,000 Erie R. R. Co. Prior Lien Bonds.		
$59,000 Erie R. R. Penn. Coll. Trust Bonds.		
$50,000 Reading R. R. Co. Jersey Cent. Coll. Trust Bonds.		
$24,000 Nor. Pac. R. R. Co. St. Paul & Duluth Div. Bonds.		
$30,000 Nor. Pac.-Gt. Nor. C. B. & Q. Coll. Tr. Bonds....		
Director-in-Chief, Working Fund.	25,000.00	
General Income Account, Balance borrowed from Permanent Funds.	2,861.43	
Income David Lydig Fund, Balance borrowed from Permanent Funds.	2,032.61	
Cash in hands of Treasurer.	22,694.18	
	$355,199.90	$355,199.90

REPORT OF THE SPECIAL AUDITOR

TREASURER'S ACCOUNT FOR THE YEAR 1909

66 BROADWAY,
NEW YORK, January 31st, 1910.

JAMES A. SCRYMSER, ESQUIRE,
Chairman of the Finance Committee,
New York Botanical Garden,
New York City.

Sir: This is to certify that I have, by your direction, examined the books and accounts of the Treasurer of the New York Botanical Garden for the year nineteen hundred and nine (1909), together with their proper vouchers and that I find the Balance Sheet and the Treasurer's Statement of Receipts and Disbursements, attached hereto, to be correct.

I have also examined the various Investment Securities, and find the same to be as reported in the said Balance Sheet.

Respectfully submitted,
(signed) J. L. MERRILL,
Special Auditor.

DIRECTOR-IN-CHIEF'S ACCOUNT FOR THE YEAR 1909

66 BROADWAY,
NEW YORK, January 31st, 1910.

JAMES A. SCRYMSER, ESQUIRE,
Chairman of the Finance Committee,
New York Botanical Garden,
New York City.

Sir: This is to certify that I have, by your direction, examined and audited the financial books and accounts of the Director-in-Chief of the New York Botanical Garden for the year nineteen hundred and nine (1909) and that I find the same to be correct and the Cash Balance to be as stated in the Current Cash Book.

This auditing does not include the examination of the vouchers for either City Maintenance or Construction Work, paid for by the City, such vouchers having been found proper and in order by the City authorities and you having decided in 1904 that a further examination of them by me was unnecessary.

I have omitted, also, a detailed examination of the Annual Membership Dues Account, as per like instructions in 1904. These dues are received by the Director-in-Chief and forwarded by him to the Treasurer, the former keeping a detailed record of the same.

Respectfully submitted,
(signed) J. L. MERRILL,
Special Auditor.

BULLETIN

OF

The New York Botanical Garden

Vol. 7. No. 25.

REPORT OF THE SECRETARY AND DIRECTOR-IN-CHIEF FOR THE YEAR 1910

(*Received and ordered printed, January 9, 1911*)

To the Board of Managers of the New York Botanical Garden.

Gentlemen: I have the honor to submit herewith my report as Secretary and Director-in-Chief for the year ending January 10, 1911.

The past year has been marked by continued progress in the development and work of all departments of the Garden.

By means of additional city appropriations for construction and for improvement of the grounds, aggregating $42,500, which became available on July 19, 1910, and by means of unexpended balances of previous appropriations, work has been continued on rock and earth excavation and disposal within the grounds, on construction of paths and roads, on drainage and water supply and on minor improvements. An ornamental concrete shelter-house for visitors has been built on the west side of the Upper Lake, and two additional greenhouses of conservatory range no. 2 are at present under construction. Much additional planting has been accomplished, including additions to all the older plantations and the establishment of new ones. Much additional land has been improved through construction operations, especially at the northern end of the grounds, where swampy areas have been reclaimed by filling and draining, and at the eastern side of the grounds in the deciduous arboretum. Through gifts and purchases and by exploration, the collections of living plants, both hardy and tender, and of museum and herbarium specimens have been much increased, and the library has received notable accessions. The labeling of plants and specimens has been continued. Direct educational work with the general public, with school children, and with special students from colleges and universities has been elaborated. The several series of publications have been continued.

Maintenance of the Garden has been accomplished by appropriations aggregating $82,994.64 made by the city of New York, supplemented by expenditures aggregating about $13,000 from Garden income, or about $96,000 in all; the necessity of supplementing the city appropriation by these expenditures prevented an elaboration of educational and scientific work which would otherwise have been possible, but a special fund of $7,500, contributed by members and friends of the Garden for the use of the Scientific Directors, enabled considerable original work to be done. The permanent funds have been increased by $50,000 bequeathed to the Garden by its late President, Mr. Darius Ogden Mills, designated, by the Board of Managers, the Darius Ogden Mills Fund; by life membership fees aggregating $1,250, by $115, fees of special students, credited to the Students' Research Fund, and by a gift of $100—credited to the Endowment Fund. The gifts of living plants, of specimens and of books during the year aggregate in value about $729.25; these have been recorded in detail in the monthly issues of the JOURNAL.

Grading and Drainage

The improvement of the north part of the Garden grounds by filling and draining marshy areas in the north meadows has been continued at intervals through the season, and the dry summer was favorable for this work, which is nearly completed, except for the filling up of the old winding course of the Bronx River, which the stream occupied before it was diverted, many years ago, into a straight course several hundred feet in length. The old river course is being taken advantage of as a place to deposit boulders, and rubbish from the plantations, and it will be useful for these purposes for some years. Drainage ditches have been dug through this area so that water does not stand there very long.

At the rear of the museum building, one of the rocky hills was completely removed and the surface regulated with topsoil and sown; work is still in progress on the removal of the other rocky hill; all the stone obtained from these hills has been used in the construction of paths and roads, and enough probably remains to complete the path system as planned.

Much grading has been done at a number of points in the arboretum on the east side of the grounds, preparatory to the planting of young trees, and in shaping banks along paths and along the river road. The surroundings of the completed portion of conservatory range no. 2 on the east side of the grounds, and of power-house no. 2, have also been partially graded and prepared for planting; minor grading work has been accomplished at other points, such as the west end of the Upper Lake, the west end of the Long Bridge, and along the driveway approach to the Woodlawn Road Bridge.

Several hundred feet of vitrified earthenware drain-pipe was laid in the north meadows east of the Bronx River, outflowing into the river, practically completing the drain-pipe system required in that part of the grounds. The earthenware drain-pipe from the cellar of conservatory range no. 2 was extended through the arboretum to the Bronx River. Minor extensions of the drain-pipe system were made at various points in the grounds, and a number of drainage basins were constructed.

Roads and Paths

The public driveway system of the Garden, as planned, is now complete with the exception of surfacing the unfinished portion from opposite the propagating houses to the southeastern entrance, a distance of about 1,200 feet. Pending the grading and opening of the Bronx Boulevard which bounds the Garden to the east, it has not been worth while to open this road, but that street is now graded, and the road may be completed by surfacing it with trap-rock screenings next season; its completion was also suspended, awaiting the determination of plans by the Park Department for a connection of this road with a Park driveway to the south; this study has now been completed, and work was commenced by the Park Department on this road-extension during the autumn; the plan requires the construction of about 100 feet of additional driveway within the Garden reservation, and establishes a very important Park driveway entrance at this point. The Telford foundation for a service road from the stable to the nurseries was built during the autumn, and another service road from the main driveway to the nurseries was completed.

The path system has been greatly extended during the year. In the north meadows, on both sides of the river, it is now nearly complete as planned, except for a stretch of about 1,000 feet along the east side of the river and a loop of about 800 feet east of the Woodlawn Road Bridge. The path approaches to the Newell Avenue entrance, at the northern end of the grounds, were partially completed, as also those to the Bleecker Street entrance, near the stable. A great deal of partial work was accomplished on paths at various points in the arboretum, which may readily be connected and completed during the next year. About 300 feet of path was built to connect paths already constructed through the woods, at points east and northeast of the herbaceous garden. A path about 500 feet in length was constructed from the east end of the second lake, through the western arch of the Long Bridge and through the marshy woods northward to the fruticetum. Short lengths of connecting paths were built at other points in the grounds. The total length of paths completed and opened during the year is 4,306 feet; the total length of paths partially completed during the year is about 3,300 feet.

The necessity of additional path connections between conservatory range no. 1 and the approach to the museum building, through the pinetum, has been becoming more and more apparent. A careful study of this subject was made early in the year and a plan was prepared by Mr. John R. Brinley, Landscape Engineer of the Garden, and approved by the Board of Managers and by the Commissioner of Public Parks, calling for about 1,000 feet of additional path construction, work on which may be commenced in the spring.

All the rock needed for the Telford foundations of paths constructed has been obtained from the necessary grading operations, and principally from behind the museum building.

The maintenance of roads and paths has been accomplished by the Park Department, under the requirement of the Garden's charter, except the weeding of paths which has been done by Garden laborers. As a whole, the system is in good condition. A thin coat of oil emulsion applied to the roads during the summer was of service. These driveways, situated as they are in the center of the northern Park system of the Borough of the Bronx, are continually subject to greater and greater wear owing to their rapidly increasing use, and consequently require increasing attention; the steeper grades and the curves are the most abraded by motor cars, and require frequent repairs. The traffic road, from the Southern Boulevard entrance to Bedford Park Boulevard entrance, was resurfaced with gravel, but the heavy truckage on this road has cut this new surface up badly, and the road is now muddy.

Bridges

The four stone bridges constructed in previous years are in good order and have required no repairs, except a few hours' time of a mason for pointing. The driveway over the Long Bridge and its curb lines have settled slightly in places between the arches, so that the vertical curve is not quite perfect; this is due to the unequal depth of filling which was necessary over and between the arches. It is desirable that this curve be made true at such time as may be convenient. The path approaches to all these bridges are now complete. At the Boulder Bridge an experiment was made in the spring with planting-pockets at eight points, using the shrub yellow-root (*Xanthorrhiza apiifolia*), a plant which spreads rapidly and widely by rootstocks. This planting was successful, but it will apparently have to be protected by railings as it has been more or less trampled.

During the year the bridge planned by the Department of Parks to replace the present wooden bridge near the Lorillard Mansion has been constructed, spanning the gorge of the Bronx River a little to the south of the old bridge, and providing a new entrance to the hemlock grove. This bridge will be a great convenience and it affords a splendid view of the gorge and the rapids of the Bronx.

Water Supply

The six-inch distributing main was extended during the year from the plaza north of the Lake Bridge completely around the northern end of the Garden along the driveway to the eastern end of the Long Bridge, connecting there with the main previously laid. It was also extended southward from a point opposite the stable along the unfinished driveway, and work is still in progress on that line; about 4,300 feet of this pipe was laid, and we still have 800 feet on the grounds ready for laying.

Buildings

The older buildings have required only ordinary repairs, but these have increased in total amount from previous years and will doubtless still further increase as the buildings become older. The entire exterior of conservatory range no. 1 was painted, as well as that of the propagating houses. Some interior painting was done in the museum building in carrying out the general scheme of tinting the walls of the museum halls, during such time as the painters were not required, during cold weather, on the greenhouses. The necessary increase in expense for repairs is especially evident in the steam-heating plant; several hundred feet of new radiating pipe has been required in conservatory range no. 1 and more will be required this year; furnace grates have to be replaced and are an item of considerable expense.

The extent of repairs required has become such that a shop for mechanics is desirable. At present the carpenter shop is in the basement of the museum building, the paint shop in the basement of conservatory range no. 1, and the blacksmith shop a temporary wooden house near the Upper Lake. It would be economical and convenient if a shop were built, located preferably in the vicinity of the stable and propagating houses on the east side of the grounds.

The shelter house, planned for construction on the shore of the Upper Lake, was built during the season; its completion was greatly delayed on account of inefficient contractors, and some work on it still remains to be done under the terms of the contract, the time limit of which has been much exceeded. It is a pleasing little building of concrete with a tile roof, and will be very useful. It is desirable that several shelter houses be built at other points of the grounds.

The extension of conservatory range no. 2, made possible by an appropriation of $25,000 by the city, was begun in November under a Park Department contract with John

R. Sheehan & Company for $23,700. This provided two additional greenhouses for this range. The excavation necessary for cellar and trenches was completed on December 22d. The foundations and nearly all the brick and stone walls of these structures have also been completed; the iron work will be put in place during the winter. It is expected that these houses will be ready for occupation in the early spring. Our plan is to move into these new houses certain portions of the collections from conservatory range no. 1 and substitute there a large portion of the collections of cactuses and other succulent plants which have been obtained during the last few years and housed in the propagating houses for want of space in the public ranges.

Boundary Walls and Fences

The iron fence constructed in 1908 along the property line of Fordham University at the southern side of the grounds has been completely painted, but has required no other repairs.

Under a tripartite agreement between the city, the New York Central and Hudson River Railroad Company, and the Garden, executed in August, under the authority of Chapter 558 of the Laws of 1909, the Railroad Company will construct at its own expense, a concrete and iron fence along the entire western boundary of the Garden, and work on this fence is expected to be commenced within a few weeks. Through this same agreement the Railroad Company has constructed a conduit along this boundary line for the telegraph and telephone wires, now strung on poles; it is expected that these wires will now be removed from the poles and placed in the conduit.

During the construction of the Bronx Boulevard along the eastern side of the grounds during the season, a retaining wall was built by the Department of Public Works, from a point opposite power house no. 2 to the northeastern corner of the grounds; this wall reaches a height of about twenty feet above the Garden land along portions of this line, and no fence construction by the Garden will here be necessary. It is desirable, however, that a fence be constructed from the south end of this wall along the Bronx Boulevard to the southeastern corner of the Garden, and that proper driveway and path entrances be provided in this fence.

Plants and Planting

During both spring and autumn, planting has gone forward at many points. All the labeled collections have been increased in number of species and varieties, many roadside trees have been planted, and groups of shrubs have been thinned and modified, the plants taken from them being used in different places. The eastern bank of the upper lake was solidly planted with rhododendrons early in the year and these deeply mulched with leaf-mould. Hosetaps placed conveniently near this plantation made it possible to carry the plants through without loss during the drought of the summer season. Additional planting was done on the shores of the second lake, set aside as an aquatic garden. Masses of rhododendron and of mountain laurel were planted at the west end of the Boulder Bridge. The south bank at the west end of the Long Bridge was planted with conifers. The improvement of the grounds in the arboretum has made it possible to set many trees in place hitherto held in the nurseries.

The greenhouse collections also have been considerably increased in number of species throughout the houses, but the arrangement has not been much modified. The temporary summer plantations in the court of conservatory range no. 1 were elaborated further than in previous years.

Display labeling of all the collections both under glass and out of doors has been continued, and over 5,200 such labels have been prepared and put in place.

Contributions of money for the purchase of plants credited to the "Plant Fund" have been received as follows:

Samuel Thorne	$100
H. C. von Post	100
S. S. Palmer	100
Mrs. E. H. Harriman	100
L. C. Tiffany	100
Arthur F. Esterbrook	100
Henry W. de Forest	100
Miss Helen M. Gould	100
Isaac M. Seligman	100
Mrs. F. L. Sturgis	100
John E. Parsons	50
Andrew G. Agnew	50
Jas. Douglas	25
P. N. Spofford	10

Mrs. Francis Lydig Sturgis kindly contributed funds for the purchase of a collection of Japanese cherry trees, and ground has been prepared for these in the arboretum in proximity to the general cherry collections; the trees will be planted in the spring.

Natural Features

The preservation of the natural features of the tract has been given much attention. The hemlock grove has been patroled almost continuously, and several fires which might have done much damage were quenched before making headway; visitors have been kept to the trails and paths as much as possible, but on crowded days the grove has been considerably overrun and some additional damage done to undergrowth. The northern end of the hemlock grove and other parts of the woodlands have been protected by low, iron-pipe fences, which have proved very useful and are not conspicuous.

Visitors have been kept out of natural thickets other than those of the hemlock grove as much as our available force of guards has permitted, but some of these thickets also should be fenced, in order to preserve their beauty. Many acres of wild land are retained as such in the north meadows, and the river woods north of the Long Bridge remains unchanged.

Museums

The general arrangement of museum objects remains as in previous years; the collections have been considerably increased by specimens more completely illustrating the subjects represented, by intercalation, and the older specimens have been inspected and preserved from deterioration. Many labels have been reprinted in order to give more complete information. Additions to these collections and to all others have been published in successive issues of the monthly JOURNAL.

A large number of original drawings of plants have been made by the Garden draughtsman, Mr. Mariolle, framed and placed in the museum cases to supplement specimens, or as substitutes for specimens of plants in cases in which an illustration serves better than the specimen itself. It is proposed to continue this work for a considerable period.

Photographs, selected especially from those obtained during exploration work in the American tropics, showing plants in their natural surroundings, and as typical specimens, have been enlarged from 4-inch by 5-inch plates to 10-inch by 12½-inch prints, suitably labeled and prepared for exhibition in frames on the walls of the museum halls. Several hundred such illustrations are now available, and being all original studies have a particular value.

The economic museum of crude plant products utilized in the arts, industries and sciences, is being more and more consulted from commercial standpoints. It is under the immediate supervision of Dr. Rusby, Chairman of the Scientific Directors, who has given much time and attention to its formation. Reference is made to his annual report.

Herbarium

This most important of the scientific collections of the Garden has been increased during the year by about 70,000 specimens, in part from specimens obtained in previous years and held in the storerooms, in part from specimens collected by the several exploring expeditions, and in part from other sources. By employing additional museum aids, most of the specimens stored have been selected and mounted, so that there is at present relatively little in storage that is desirable for the permanent collections. Noteworthy in this connection is the large herbarium of the late Dr. Otto Kuntze, purchased for the Garden two years ago by Mr. Carnegie, the moss herbarium of the late William Mitten, presented several years ago by friends of the Garden, and the large and representative collection of seaweeds, brought together by Curator Dr. Howe. The study, classification and distribution of these specimens has taxed the time of the curatorial staff; it is with great satisfaction that I am able to report that the herbarium is greatly improved for purposes of consultation, and that it is being more and more used by students from all parts of the country.

Contributions of money credited to the "Museum and Herbarium Fund" and expended for the purchase of herbarium and museum specimens were received during the year as follows:

Addison Brown	$300
Francis Lynde Stetson	100
Cleveland H. Dodge	100
Miss Catherine A. Bliss	100
Louis Marshall	100
Lowell M. Palmer	100

Library

The report of the Librarian, Dr. Barnhart, herewith submitted, shows that the library now contains 22,939 bound volumes, 1,231 volumes having been added during the year. Many thousand pamphlets also are included in this collection. This large increase is mainly due to a trip made by Dr. Barnhart to Europe during the summer as previously arranged for, for the purpose of purchasing books from bookdealers, by means of contributions made to the special fund for the use of the Scientific Directors. This method of obtaining rare books was wholly successful, and prices were obtained lower than the advertised ones of bookdealers. Much progress has been made in completing the collection of the older literature, undertaken several years ago, but much still remains to be secured. By means of special contributions we have been able to expend an average of about $2,000 a year for this older literature for the past ten years, and we hope that this rate of progress may be maintained.

Like the other collections of the Garden, the library is being more and more consulted by students from other institutions, and the more complete it is made the more useful it will be.

Additional book shelves are now greatly needed and application for such will be made to the Commissioner of Parks at the earliest opportunity. Somewhat larger provision for the binding of books has become necessary, owing to the increase in the size of the collection and to its increased use.

Contributions of money credited to the "Special Book Fund" and expended for the purchase of books were received during the year as follows:

J. Pierpont Morgan	$500
Wm. K. Vanderbilt	320
Chas. F. Cox	100
Edward D. Adams	100
Miss Elizabeth Billings	100
James Speyer	100
Geo. S. Bowdoin	100
Cornelius N. Bliss	50
Adrian H. Joline	25
John S. Huyler	25
Wm. Church Osborn	25
Geo. E. Barron	10
James W. Cromwell	10

Laboratories

The report of the Director of the Laboratories, Mr. Seaver, shows that during the year 39 special students and investigators have taken advantage of the facilities for study offered by the Garden, in consultation with various members of the staff; this number is somewhat higher than the average of the past ten years, and a great variety of subjects has been included in the investigations prosecuted. The system of conferences of students and members of the staff on the first Wednesday of each month has been continued. Reports of the subjects discussed at these conferences have been published in successive numbers of the JOURNAL.

The Director of the Laboratories has also given close attention to diseases of trees and of other plants caused by insects and fungi, and has answered a great many inquiries in this important subject of plant pathology. He also had the meteorological records in charge; the principal meteorological feature was the protracted summer drought, details of which were published in the October JOURNAL.

The Tropical Laboratory, maintained by the Garden in cooperation with the Department of Agriculture of the island of Jamaica, continues to be very useful; it was occupied during the summer by Professor Duncan S. Johnson of Johns Hopkins University with five research students interested in plant ecology and plant cytology. A visit to Cinchona is an important part of the liberal education of a botanist, whether subsequently engaged in teaching or in investigation.

Teaching

Public lectures, covering a wide range of botanical and horticultural topics, have been delivered on each Saturday afternoon from April 30 to November 19. In previous years such lectures have been given in two series, one in the spring, the other in the autumn, but this year they were given also during the summer months, as proposed in my last annual report; the result was wholly satisfactory, the summer audiences averaging only slightly smaller than those of spring and autumn. All but three of these lectures were delivered by members of our staff; the titles are listed in the report of the Assistant Director, herewith submitted. Winter lectures have not been attempted; there has been some inquiry for them, and they may be arranged for when practicable. The Scientific Directors have considered providing certain lecture courses, in addition to the diverse popular Saturday afternoon series; these would be of a somewhat more technical and scientific character, and might be given through the winter; lecturers additional to members of the present staff would be necessary, and a smaller lecture-room would be needed.

Pusuant to authority given me by the Board of Managers at a meeting held May 12, 1910, I appointed Mr. Percy Wilson a docent on July 1, and assigned him, as principal duties, the conducting of visitors who apply for special attention, through the grounds and buildings, the directing of them to various features of the collections, and informing them on subjects botanical, horticultural and economic. This provision for instruction was taken advantage of by large numbers of visitors, including many school parties. The following schedule of routes was followed, starting from the front approach to the museum building at three o'clock and ending between five and six in the afternoon.

Monday: Hemlock Forest and Herbaceous Garden.
Tuesday: Pinetum.
Wednesday: Fruticetum and North Meadows.
Thursday: Deciduous Arboretum, Nurseries, Propagating Houses.
Friday: Public Conservatories.
Saturday: Museums.

In case no application is made for such guidance and instruction, the docent goes out on the grounds and engages visitors in conversation, which usually leads to the examination of some plants or other features of interest. Besides the regular schedule above recorded, the docent escorts parties by appointment, at other hours. It is mostly afternoon work, and the docent has been occupied with curatorial and editorial duties during the mornings. For the coming year it is proposed to appoint Mr. Wilson an Assistant Curator and to add docentry to this position.

It seems likely that more than one docent may be needed, inasmuch as this type of teaching is very much enjoyed, and expressions of gratitude are frequent by visitors; no fee is charged or accepted for the service.

In the autumn, lectures and demonstrations to children from the public schools were taken up again, and given four afternoons of each week. Slight modifications were made in the method, the routes being shortened and the number of demonstrators increased; this made it possible to keep the children on the grounds for a somewhat shorter time than on previous occasions, so that they reached their homes earlier in the day.

The edition of the guide-book published last year has sufficed. The further modification of the arrangement of the conservatory collections, made possible by the building of the additional greenhouses, and the general development of the grounds, will make it desirable that another edition of the guide-book be prepared during the present year.

Floral Exhibitions

For several years, in cooperation with the Horticultural Society of New York, special exhibitions of plants and flowers, open to all, have been held at intervals in the basement halls of the museum buildings, the Garden paying part of the prizes. One such exhibition was held during the past year, on Saturday, June 4, and continued through Sunday, June 5. These exhibitions are highly appreciated by the visiting public, and the Garden is often the recipient of plants exhibited. It is very desirable that they be increased in number; monthly intervals from May until

October would not be too frequent, and the Horticultural Society has expressed willingness to cooperate to this extent. The budget provides an appropriation of $400 for horticultural prizes which is scarcely sufficient for six exhibitions.

Exploration

Exploration of parts of tropical America, botanically little known, has been continued and the collections of living plants and of museum and herbarium specimens have received valuable and important additions through this work. Many species are now represented here which are not possessed by any other institution, and noteworthy contributions have been made to botanical science.

Dr. Marshall A. Howe, Curator, returned on January 19 from the Isthmus of Panama, where he had spent about six weeks with Mrs. Howe in the study of the algae on both the Atlantic and Pacific Ocean sides of the Canal Zone. Dr. W. A. Murrill, Assistant Director, spent December, 1909, and January, 1910, with Mrs. Murrill in southern Mexico, studying and collecting the fungi of that region. Andros Island of the Bahama Archipelago was explored by Dr. John K. Small, Head Curator, in company with Mr. J. J. Carter, during the latter part of January and the early part of February. In company with Mrs. Britton, Mr. Percy Wilson, Administrative Assistant, and Mr. F. S. Earle, formerly a curator of our museums, I explored the Trinidad Mountains and the coastal region of the Province of Santa Clara, Cuba, being absent for that purpose from February 17 until April 6. An exploration of the north coast of Camaguey Province, Cuba, and of the mountains of the northern part of Oriente Province, Cuba, was accomplished by Dr. J. A. Shafer, Special Agent, from October, 1909, until March 30, 1910. During the latter part of August and most of September, I conducted exploration work in the western part of Cuba in company with Mrs. Britton, and with Dr. C. Stuart Gager, Director of the recently established Brooklyn Botanic Garden, and this work was supplemented during December by Mr. Percy Wilson, who collected on the north coast of Pinar del Rio, and, in company with Brother Leon, of the College of La Salle, at points in the vicinity of Havana. Dr. Shafer returned to eastern Cuba in November.

Parts of August and September were spent by Mr. Fred J. Seaver, Director of the Laboratories, in collecting fungi in Colorado in cooperation with Professor Elsworth Bethel, of the East Denver High School. Mr. Norman Taylor, Assistant Curator, continued his studies of the local flora in the vicinity of New York in cooperation with members of the Torrey Botanical Club; Mr. Taylor is now occupied in preparing for publication the results of his studies, which have extended over several years. Dr. H. H. Rusby made a large and valuable collection in Mexico.

This exploration work has been mainly accomplished by means of contributions to the special fund of the Scientific Directors as follows:

Andrew Carnegie	$1,000
John Innes Kane	500
James B. Ford	500
Wm. D. Sloane	250
Jno. D. Archbold	250
Mortimer L. Schiff	250
Geo. W. Perkins	250
Edward S. Harkness	250
N. L. Britton	250
James A. Scrymser	100
W. Bayard Cutting	100
H. C. Fahnestock	100
Thos. H. Hubbard	100
Robert W. de Forest	100
Mrs. Morris K. Jesup	100

There is so much still to be learned about the American flora and such a large number of species exist, especially in the tropics, which are not yet represented in our collections, that this work of exploration may profitably go forward for a long period of time. The duplicate specimens which are obtained are used in an important way as exchanges with other institutions, and through these exchanges many valuable specimens and plants are received. Noteworthy exchanges of the present year have been made with the United States National Museum, and the United States Department of Agriculture at Washington; with the Field Museum of Natural History of Chicago, with the Royal Botanic Gardens at Kew, England, with the Botanical Garden and Museum at Berlin, Germany, with the Bureau of Science of the Philippine Islands at Manila, with the Jardin des Plantes, Paris, France, and with the Geological and Natural History Survey of Canada.

Investigations

Curatorial and administrative work has required most of the time of the scientific staff, but such as could be spared has been devoted to original investigations, though most of what has been done has been accomplished outside of regular hours of attendance. Students and visiting officers from other institutions have used the facilities of the Garden for research to great advantage. Members of the staff have also made visits to other institutions for comparative studies of their collections. A noteworthy trip was made by Dr. Murrill, Assistant Director, to the botanical museums of northern Europe in the autumn for a comparative study of the larger fungi related to mushrooms, during which results of much scientific importance were reached. The publications of the Garden have been continued by the aid of the income of the David Lydig Fund bequeathed by the late Ex-Chief Justice Charles P. Daly. A detailed account of these is given in the report of the Assistant Director, herewith submitted.

Research Scholarships

The system of granting worthy students research scholarships, carrying allowances of $50 a month during residence, has been continued with good results. The available funds have permitted such grants for only short periods, and it is most desirable that this work should be expanded.

Mr. Frank D. Kern held a scholarship during January while continuing his investigations on the parasitic fungi known as rusts. Mr. Kern is again at the Garden during this winter, holding a Columbia University fellowship.

Mr. Ralph C. Benedict was awarded a scholarship for the month of June while studying the tropical fern genus, *Vittaria*.

Professor Le Roy Abrams held a scholarship of six weeks in the summer, during which time he completed his studies on the trees and shrubs of southern California by reference to the specimens preserved in the Garden herbarium. His valuable paper on this subject has been published in Garden BULLETIN, no. 21.

Mr. David R. Sumstine held a scholarship during July while engaged in investigations on the moulds of North America.

Preservation of Native Plants

The income of the fund of $3,000 for the preservation of native plants, presented to the Garden by the Misses Caroline and Olivia Phelps Stokes several years ago, has been allowed to accumulate in order that some larger plan of usefulness for it should be adopted. This accumulated income now amounts to $419.13, which, with the present year's income, will provide over $500 available for expenditure.

Public Exhibits

The Garden participated in the Budget Exhibit arranged by the Board of Estimate and Apportionment in the autumn for the purpose of demonstrating details of the expenditures of public moneys. The objects used in this exhibit were mainly photographs and drawings, together with tables and figures showing the city appropriations, and expenditures from funds of the Board of Managers, during the past three years.

The Garden is also preparing to participate in the Child's Welfare Exhibit to be held during January and February, 1911, in which similar objects will be used.

Police Protection

As mentioned in previous reports, the Charter of the Garden places the grounds under the control of the Department of Parks for police purposes, but, as also previously recorded, the police protection has been entirely inadequate, owing to the fact that the Park Commissioner had been refused detail of men by the Police Department. It has therefore been necessary to employ keepers, sworn in as special officers, and pay them from our own appropriations. Two such special officers have been employed during most of the year, and two foremen and the Head Steam Engineer have also been sworn in for this service. It would appear, after long endeavor, that this plan must be followed unless some modification of the City Charter provides the Commissioners of Parks with police under their own Control, as formerly, or the Police Department assumes direct responsibility. On Sundays and holidays it has been necessary to use gardeners and laborers, sometimes as many as ten men, in addition to the special officers, for the control of visiting crowds.

Administrative

Many of the details of maintenance have been carried out by Dr. Murrill, Assistant Director, acting under my general instructions, aided by Mr. Percy Wilson, who was Administrative Assistant from January until July, and by Mr. R. S. Williams, who occupied this position from July until December. The construction work has been under my own immediate supervision, aided by Colonel Schilling, Superintendent of Grounds. The installation of new collections has been under my own immediate direction, aided by the curators and by the Head Gardener. Such of my own time as could be spared from administrative work has been given to the study of the collections, and to a continuation of my investigations on the American flora; my studies of the Cactaceae, in cooperation with Dr. J. N. Rose of the United States National Museum, have also been continued.

Financial Considerations

For maintenance of grounds, buildings and collections, the city appropriations for 1911 aggregate $85,994.64, an increase of $3,000 over those for 1910. The total sum actually required for maintenance, in order that no progress which has been made shall be lost, and that no serious deterioration of grounds or buildings shall ensue, is estimated at about $98,500, approximately $2,500 more than our expenditures for maintenance during 1910, due to improvement of considerable areas of land and to the erection of additional buildings by means of city appropriations. In order to obtain about $98,500 the budget for 1911 included items aggregating $12,500 from our General Fund income to supplement the city maintenance allowances, which is about as much as we have had to contribute during each of the past four years. If the city appropriation were in itself sufficient, so that these annual contributions from our funds were unnecessary, the educational and scientific work of the Garden could be much expanded.

The present annual income from invested funds, membership dues, sale of publications and sundries is about $30,000, this, added to the city maintenance appropriations of nearly $86,000 makes about $116,000 available for expenditure, although it is desirable that about $4,000 income be reserved to reimburse the General Fund for sums borrowed from it in previous years, and this is provided for in the budget. In order to carry on all the work of the Garden to the best advantage, in its present development, about $130,000 is needed annually, or about $18,000 more than is carried in the budget for 1911; an increased endowment is, therefore, greatly desired.

Reports Appended

Details of the work accomplished during the year will be found in the reports hereto appended, submitted by the Assistant Director, the Head Gardener, the Head Curator of the Museums and Herbarium, the Honorary Curator of the Economic Collections, the Director of the Laboratories, the Librarian, and the Superintendent of Grounds, and in a schedule of expenditures under appropriations made by the Board of Managers, submitted by the Accountant.

Respectfully submitted,
N. L. BRITTON,
Director-in-Chief.

REPORT OF THE ASSISTANT DIRECTOR

To the Director-in-Chief.

Sir: I have the honor to submit the following report for the year 1910.

Grounds and Buildings

The grounds and buildings have been successfully maintained during the year at a minimum expense; and the amount of damage sustained from storms, fires, and disorderly persons has been very slight.

The growing season was the most severe in the history of the Garden, the unusually wet spring developing heavy foliage with a poor root system, while the prolonged summer drought extracted more water from the leaves than the roots could replace. Although much artificial watering was done, it is feared that there was more damage to the plantations than has yet become manifest.

In the control of plant diseases, which is always difficult in a large collection of plants, we have been very fortunate. The San José and other scale insects, the "red spider," "green fly," and imported elm leaf-beetle, have all been controlled by judicious and opportune spraying; the chestnut canker has settled its own problem by killing all of the chestnut trees; there remains only the leaf-blight of the plane-tree, which has been very severe for several seasons from about the middle of May to the first of July, and this disease cannot be controlled by ordinary methods. Owing to the growing importance and scope of this work, Mr. Fred J. Seaver, Director of the Laboratories, who has devoted considerable time to plant pathology, has been asked to supervise it.

The interest shown by the visiting public has been greater than ever before, and a large majority of the visitors have respected the wishes of the management in the use of the grounds, but we have been gradually forced against our will to erect barriers, multiply signs, and detail guards to enforce regulations for protecting the collections.

The usual necessary repairs and renovations have been made as in former years, the details of which are outlined in the report of the Superintendent.

Publications

The publications of the Garden have been more in demand than during any previous year; doubtless owing to the fact that they are becoming more widely known and recognized as a very substantial contribution to the botanical literature of the world.

JOURNAL

The JOURNAL has been published for each month during the year, making a volume of 289 pages with 7 plates and 42 figures.

MYCOLOGIA

This periodical has appeared on alternate months during the year, making a volume of 320 pages with 17 plates and 17 figures. Twenty-six species of fungi were illustrated in their natural colors in this volume.

BULLETIN

BULLETIN no. 24, with 121 pages, was issued March 17, 1910. It contains the annual reports of the Director-in-Chief and other officers for the year 1909.

BULLETIN no. 21, containing 259 pages and 10 plates, was issued September 27, 1910. The following articles compose the number: "Bolivian Mosses. Part II," by R. S. Williams; "Critical Notes on New or Little Known Species in the Herbarium of the New York Botanical Garden," by B. P. G. Hochreutiner; and "A Phytogeographic and Taxonomic Study of the Southern California Trees and Shrubs," by Le Roy Abrams.

BULLETIN no. 22, completing the sixth volume, contains "New Species from Bolivia, Collected by R. S. Williams

—I," by H. H. Rusby, and two indexes, making a total pagination of 528 pages for Volume VI.

CONTRIBUTIONS

Contributions by members of the staff or students of the Garden reprinted during the year from other than Garden publications, are as follows:

No. 129. "Studies on the Rocky Mountain Flora—XX," by Per Axel Rydberg.

No. 130. "Monographia Generis Arthroclianthi Baill.," by B. P. G. Hochreutiner.

No. 131. "Studies on the Rocky Mountain Flora—XXI," by Per Axel Rydberg.

No. 132. "*Sphaerocarpos hians* sp. nov., with a Revision of the Genus and Illustrations of the Species," by Caroline Coventry Haynes.

No. 133. "Iowa Discomycetes," by Fred Jay Seaver.

No. 134. "Studies on the Rocky Mountain Flora—XXII," by Per Axel Rydberg.

No. 135. "Studies of West Indian Plants—III," by Nathaniel Lord Britton.

No. 136. "Notes on Rosaceae—III," by Per Axel Rydberg.

No. 137. "Studies on the Rocky Mountain Flora—XXIII," by Per Axel Rydberg.

No. 138. "Notes on Rosaceae—IV," by Per Axel Rydberg.

NORTH AMERICAN FLORA

Volume 9, part 3, containing descriptions of the Family Boletaceae by W. A. Murrill, and the Agaricaceae (pars) by W. A. Murrill and Gertrude S. Burlingham, was issued February 3, 1910.

Volume 25, part 2, containing descriptions of the Family Tropaeolaceae by G. V. Nash, the Balsaminaceae and Limnanthaceae by P. A. Rydberg, the Koeberliniaceae by J. H. Barnhart, the Zygophyllaceae by Miss A. M. Vail and P. A. Rydberg, and the Malpighiaceae by J. K. Small, was issued June 3, 1910.

Volume 3, part 1, containing descriptions of the Families Nectriaceae and Hypocreaceae by F. J. Seaver, the Chaetomiaceae by Helen L. Palliser, and the Fimetariaceae by David Griffiths and F. J. Seaver, was issued December 29, 1910.

Lectures

PUBLIC LECTURES

Illustrated public lectures on botanical subjects have been given in the museum building on Saturday afternoons from April to November, as follows:

April 30. "Spring Flowers," by Dr. N. L. Britton.

May 7. "Collecting in Southern Mexico," by Dr. W. A. Murrill.

May 14. "The Origin and Formation of Coal," by Dr. Arthur Hollick.

May 21. "Water Lilies," by Mr. George V. Nash.

May 28. "An Expedition to the Panama Canal Zone," by Dr. M. A. Howe.

June 4. "Summer Flowers," by Dr. N. L. Britton.

June 11. "The Rose and Its History," by Mr. George V. Nash.

June 18. "The Native Trees of the Hudson Valley," by Mr. Norman Taylor.

June 25. "The Extinct Flora of New York City and Vicinity," by Dr. Arthur Hollick.

July 2. "The Fungous Diseases of Shade-Trees," by Dr. W. A. Murrill.

July 9. "Botanical Features of the West Indian Islands," by Dr. N. L. Britton.

July 16. "Interesting Relations between Plants and Animals," by Mr. F. J. Seaver.

July 23. "The Forms of Flowers and their Meaning," by Dr. C. C. Curtis.

July 30. "By Canoe down the Yukon River, Alaska," by Dr. Arthur Hollick.

Aug. 6. "Edible Mushrooms," by Dr. W. A. Murrill.

Aug. 13. "Influences which Govern Local Distribution of Plants," by Mr. Norman Taylor.

Aug. 20. "Botanical Cruises among the Bahama Islands," by Dr. M. A. Howe.

Aug. 27. "Grasses and their Economic Importance," by Mr. George V. Nash.

Sept. 3. "Poisonous Mushrooms," by Dr. W. A. Murrill.

Sept. 10. "European Influences in the History of American Botany," by Dr. J. H. Barnhart.

Sept. 17. "Orchids, Wild and Cultivated," by Mr. George V. Nash.

Sept. 24. "The Botanical Gardens of Europe," by Dr. W. A. Murrill.

Oct. 1. "Some Floral and Scenic Features of Jamaica," by Dr. M. A. Howe.

Oct. 8. "Carnivorous Plants," by Dr. H. M. Richards.

Oct. 15. "Autumn Flowers," by Dr. N. L. Britton.

Oct. 22. "Plant Diseases and their Control," by Mr. F. J. Seaver.

Oct. 29. "Explorations in Santo Domingo," by Mr. Norman Taylor.

Nov. 5. "The Flora of Switzerland," by Professor E. S. Burgess.

Nov. 12. "Some Economic Plants of Mexico," by Dr. H. H. Rusby.

Nov. 19. "Cuba: Its Flora and Plant Products," by Dr. N. L. Britton.

School Lectures

The usual lectures and demonstrations were given in the autumn to the public school children of the 4B and 5B grades, of the Borough of the Bronx, under the auspices of the Board of Education, as follows:

Grade 4B

Lecture I, "Seedless Plants," by Dr. Marshall A. Howe, was given to groups of pupils on October 17 and October 18.

Lecture II, "Cultivation of Plants," by Mr. George V. Nash, on October 24 and October 25.

Grade 5B

Lecture I, "Industries Depending Upon Forests. Plant Products," by Dr. H. H. Rusby, on October 10 and October 11.

Lecture II, "Woody Plants and Plants without Wood. Protection of Trees in Cities," by Mr. F. J. Seaver, on October 19 and November 1.

Lecture III, "Classification of Plants," by Dr. N. L. Britton, on October 26 and October 27.

Scientific Meetings

The monthly Conferences of members of the staff and students have been continued with success, and a report of each meeting has been published in the current number of the JOURNAL.

The Torrey Botanical Club has met each month as usual in the morphological laboratory of the museum building.

The Horticultural Society of New York, in cooperation with the New York Botanical Garden, held an exhibition of plants and flowers in the museum building on June 4 and 5. An account of this exhibition was published in the July JOURNAL.

The Northern Nut-Growers' Association met at the Garden on November 17 for permanent organization. An interesting exhibition of various kinds of nuts formed a feature of the meeting.

Personal Investigations

Returning from Mexico late in January, I at once began to study and arrange the large collections of tropical gill-fungi obtained by various exploring expeditions sent out by the Garden in recent years, and, later in the year, specimens of most of these were taken to Europe and compared with type material. A series of articles covering this group of fungi will be published in MYCOLOGIA, beginning with the number for January, 1911.

During the spring and summer, my studies of local edible and poisonous species of gill-fungi were continued, and a number of colored plates were prepared under my direction for publication in future numbers of MYCOLOGIA. This feature has proved very attractive and helpful to students. Professor Gies and his assistants have cooperated with me in the study of mushroom poisons, obtaining valuable results by physiological and chemical methods. A preliminary article on this subject appeared in the November number of MYCOLOGIA.

Continuing my investigations of woody fungi, a list of the polypores found in the island of Jamaica was prepared and published, and a similar list of the polypores of Mexico was completed, each list containing a number of species previously undescribed.

Respectfully submitted,
W. A. MURRILL,
Assistant Director.

REPORT OF THE HEAD GARDENER

Dr. N. L. Britton, Director-in-Chief.

Sir: I have the honor to submit the following report for the year 1910.

Systematic Plantations

Herbaceous Grounds. The collection of herbaceous plants contains about 2,750 species and varieties. There are 123 beds in this tract. There have been 961 wooden show labels added, 905 individual labels, and 56 family labels.

Fruticetum. About 1,625 specimens here represent about 720 species and varieties. There have been 166 lead show labels installed.

Salicetum. In this collection there are 35 species and varieties, represented by 102 specimens. There have been 31 lead show labels added.

Deciduous Arboretum. There are about 277 species and varieties, including those native to the tract. There have been 245 lead show labels made for this collection.

Pinetum. The collection of conifers contains 272 species and varieties; there are about 1,050 specimens. 266 lead show labels have been added.

Viticetum. There are 46 species represented here. 12 lead show labels have been added.

Conservatories. The collection of tender plants, including those at the propagating houses, represent about 206 families, 1,440 genera, and 8,300 species and varieties. The total number of plants in the conservatories is about 13,571.

Range No. 1. There have been added here 2,129 show labels, of which 2,070 were zinc and 59 lead. The collections here compromise 12,281 plants, distributed as follows: no. 1, 192; 2, 371; 3, 620; 4, 432; 5, 1,225; 6, 915; 7, 958;

8, 1,180; 9, 112; 10, 1,169; 11, 302; 12, 1,165; 13, 507; 14, 825; 15, 2,228; cellar, 80.

RANGE No. 2. There have been 225 show labels added here, of which 213 were zinc and 12 lead. There are about 1,290 plants, distributed as follows: west house, 76; middle house, 133; east house, 60; north and south house, 1,015; runway, 7.

PROPAGATING HOUSES AND NURSERIES. A large amount of propagating has been accomplished, not only of young plants to safeguard the systematic collections, but also of bedding plants for the decorative collections. There have been received 1,327 packets of seeds, as follows: by gift, 23; by exchange 652; collected on expeditions by members of the staff, 68; by purchase 42; by collection on the grounds, 542. The plants here, including those in the cold frames, number about 10,651.

LABELING, RECORDING, AND HERBARIUM. The details of this work have been attended to by one gardener and one aid. There have been 841 lead labels repaired. In addition to this, the following new show labels have been made; arboretum, 245; herbaceous grounds, 961; morphological garden, 96; economic garden, 172; border at elevated approach, 71; west border, 332; salicetum, 31; fruticetum, 166; pinetum, 266; viticetum, 12; along driveways and paths, 398; conservatory decorative beds, 189; conservatories, 2,354; total 5,293.

Accession numbers 31,777–33,155 have been recorded, making a total of 1,379 accessions. The following plants have been acquired: by gift, 136; by exchange, 553; derived from seeds, 1,554; by collections made by members of the staff and others, 298; by purchase, 4,649 (including 2,170 bulbs); by propagation from cuttings, 1,500; total, 8,690.

To the herbarium of cultivated plants, 419 specimens have been added.

The following is the approximate number of kinds of plants in each collection: conservatories, 8,300; herbaceous grounds, 2,750; fruticetum, 720; salicetum, 35; arboretum, 277; pinetum, 272; viticetum, 46; total 12,400.

Miscellaneous Collections

MORPHOLOGICAL GARDEN. There are twenty beds here, one having been added the past year; this addition contains plants illustrating species and hybrids. The plants employed are: *Hibiscus Moscheutos* and *H. oculiroseus*, and a hybrid between the two which originated on the grounds. There have been 96 show labels added.

ECONOMIC GARDEN. This is one of the collections that is most attractive to the general public. There are 31 beds, here, 24 devoted to food plants, 5 to medicinal plants, and 1 each to fiber plants and plants yielding condiments and relishes. 172 show labels have been made for this collection.

DESERT PLANTS. In addition to the three beds formerly given to this collection, two more were added, placed obliquely to the others and paralleling the terrace. The large center bed and the one immediately to the west contained American desert plants; that immediately to the east of the center bed, such plants from southern Africa; in the westerly new bed were the desert plants from the Old World; and in the corresponding bed on the other side of the court was the orpine family, this illustrating a single family with a distribution in both the Old World and the New. This general collection of desert plants continues to be one of the most attractive features of the institution. Especial interest attached to it the past summer from the flowering of the American century plant, *Agave americana*, which attracted many visitors.

CONSERVATORY LILY POOLS. Owing to a delay due to necessary repairs in the westerly pool, the young lily plants could not be set out as early as usual; in consequence, the display of the tender lilies was not as great as in some years past. The hardy lilies in the easterly pool bloomed freely the entire summer.

AQUATIC GARDEN. This is being continually developed, a large number of trees, shrubs, and herbaceous plants having been added the past spring and fall. It is proving one of the most attractive features of that part of the grounds. During the summer months there is a large and fine display of water lilies. The yellow lotus, which at one time threatened to extend beyond desirable limits, has been almost destroyed by the muskrats, upon which a war of extermination is being waged.

OTHER DECORATIVE PLANTATIONS. Under this heading are included the flower garden to the north of the conservatory range 1, and those at the elevated approach and west border. In these, mainly herbaceous plants are used, with a background of shrubs and trees. They form attractive features from earliest spring to late in the fall, beginning with snowdrops and other bullous plants and terminating with the late-flowering asters. 592 show labels have been made for these beds, distributed as follows: conservatory beds, 189; elevated approach, 71; west border, 332.

General Horticultural Operations

The force for carrying on this work consisted of 2 foreman-gardeners, 19 gardeners, 1 apprentice, and about 23 laborers and 3 drivers during the open season. The details of the conservatory work have been under the direction of foreman gardener, Richard Richter; under him were 12 gardeners, 1 apprentice, and 1 laborer during the open season. The details of the outside work have been carried out by foreman gardener, John Finley, who has had under him 7 gardeners, 22 laborers, and 3 drivers.

A large amount of general planting was acccomplished during the spring and fall. The following was done during the spring: a large tulip-tree, previously root-pruned, was successfullly transplanted to fill a gap in one of the rows of the museum approach; the Irish junipers forming the back row of the planting around the museum fountain were removed, proving unsuited to the purpose, and replaced with the pyramidal form of the arbor-vitae; the group of conifers at the west end of the Long Bridge was increased by the addition of others secured by exchange and by purchase; the plantation of conifers at the foot of the stone abutment of the Woodlawn Bridge was extended, and this carried out onto the embankment of the road; the west bank of the upper lake was planted with red and yellow-stemmed *Cornus;* the bank extending from the Boulder Bridge to the path dividing the lower from the middle lake was planted with North American shrubs; in the small beds on the Boulder Bridge were placed plants of the shrub yellow-root; in the small lake on the east side of the river, just north of the same bridge, were planted a number of water lilies; at the south end of the salicetum, along the roads and paths, groups of willows and *Cornus* were set out; a portion of the triangle in the same vicinity, opposite the *Spiraea* collection in the fruticetum, was planted with *Spiraea*, and a point about opposite this across the road was planted with *Deutzia;* at the North Bridge 12 red oaks were planted, 3 on each side of the road west of the bridge, the remainder on the north side of the road east of the bridge; at the southwest corner of the same bridge a group of *Forsythia* was installed, and immediately across the path from this a group of *Weigela.*

The most important and extensive spring planting was of rhododendrons and mountain laurels. These plants were mainly secured by purchase, a few being obtained by exchange. The bank at the east end of the upper lake and the adjacent triangle were planted with two American rhododendrons, *R. maximum* and *R. catawbiense*, with some mountain laurel and a few other shrubs. The planting of rhododendrons on the neighboring bank was extended, and a group of them and another of mountain laurel were placed at the west end of the Boulder Bridge.

During the fall, the following planting was done: at the east end of the Long Bridge a group of Japanese barberries was placed on the south side of the road, and on the south side of this bridge the group of viburnums was extended; in the fruticetum, the bank dividing the path from the road, opposite the pea, honeysuckle and thistle families, was planted with shrubs belonging to those families;

the viburnum group in the triangle south of the museum was replanted, the surplus being used in planting the fruticetum bank and the group of those plants at the Long Bridge, already referred to; a large group of shrubs was placed in the fruticetum, along the eastern path in the vicinity of the hydrangea and gooseberry families, thus screening from view the large compost pile; the collection of shrubs of the hydrangea family, near the west gate of the Southern Boulevard, was rearranged, about one half of the material being removed to form part of the screen in the fruticetum, referred to above; Japanese barberries were placed at the Newell Avenue entrance; 5 red oaks were planted south of the road near the east end of the North Bridge, completing the proposed tree-planting there; 11 poplars were set along the road through the north meadow, west of the river; the planting of Japanese barberries on the approach to the Woodlawn Road bridge was extended by adding about 45 more plants; the screen of shrubs between the river and the lower lake was increased by the addition of more wild material secured from the grounds; the planting on the island south of the Boulder Bridge, and that to the east of the river and north of the same bridge were extended, and a large area at the western end of the upper lake was planted, all with wild shrubs secured on the grounds; a portion of the east border, parallelling the nursery, was planted with maples and poplars; the large plants of the Japanese barberry, removed from the Harlem Railroad depot, were planted in the east border, near the power house, at the lower end of the retaining wall; a ginkgo tree at the depot plaza, destroyed by an automobile, was replaced with another; and a row of 10 ginkgo trees was placed opposite the existing row, northeast of the museum.

The routine horticultural operations were carried on, including the collection of all fallen leaves possible, which were placed in piles for the formation of leaf-mold, a greater quantity of which is demanded each year by the increasing horticultural operations. Owing to the unusual drought of last summer, it was necessary to water frequently all the newly planted material and also much of that which had been in position for several years.

Investigations

In addition to my ordinary duties, I have continued my studies upon the grasses for NORTH AMERICAN FLORA.

Respectfully submitted,
GEORGE V. NASH,
Head Gardener.

REPORT OF THE HEAD CURATOR OF THE MUSEUMS AND HERBARIUM

DR. N. L. BRITTON, DIRECTOR-IN-CHIEF.

Sir: I have the honor to submit the following report for the year 1910.

The collections in my care were conserved by methods adopted heretofore. They were developed along the usual lines, and were increased as follows:

By gifts and purchases	6,941	specimens
By exchanges	9,755	specimens
By exploration	25,995	specimens

Thus an aggregate of 42,691 specimens was added to the collections of the Museums and Herbarium.

A total of 4,922 duplicate specimens was sent to other institutions and individuals in exchange.

Museums

THE FOSSIL PLANT MUSEUM received attention along two main lines; first, the replacing of specimens already on exhibition by individual specimens better adapted to illustrate features of interest, second, the study and labeling of unnamed material, and the further cataloguing of the type specimens. The public exhibit in the floor cases has been completely furnished with exhibition blocks, and nearly all the specimens with printed labels. The additions to this collection were mostly from North America.

THE ECONOMIC MUSEUM was increased chiefly by the installation of three large collections; the first a series of the food-plants of the western United States, the second a series of the food-plants of Mexico, and the third a series of miscellaneous drug-plants from all parts of the globe. Miscellaneous economic specimens, which were largely secured on the Garden's exploring expeditions, were also added throughout the museum.

A beginning was made in the installation of a series of large drawings to illustrate the plant, or a portion of the plant, from which the various plant products exhibited in this museum are derived. Many drawings of a similar character of North American trees were made preparatory to the further development of the collection of North American dendrology. (For details see report of the Curator of the Economic Collections.)

THE SYSTEMATIC MUSEUM, consisting of the Synoptic Collection, the Local Flora, and the Microscope Exhibit, was increased by the interpolation of miscellaneous specimens or improved by the replacement of individual specimens in the different series. Much valuable material thus added was derived from the results of the several recent exploring expeditions maintained by the Garden.

A plan developed early in the year for the display of large photographs in the spaces between the windows of the halls and wings of this museum was carried forward as far as possible. The photographs are made, the card-mounts and frames are in hand, and a large part of the label copy is in the hands of the printer. It is planned to install this new element of the Systematic Museum early next year.

Herbaria

The general herbarium was enriched by material from many parts of the globe, but especially from America north of the Isthmus of Panama and from the Philippine Islands.

About 50,000 herbarium sheets, containing fully 70,000 specimens, were mounted and incorporated in the herbarium cases. These accessions represent, in addition to various minor collections and many miscellaneous specimens acquired during this and previous years, the results of exploration in the Bahamas, Cuba, Santo Domingo, and Panama, as well as other portions of the North American mainland, and the American specimens from the Otto Kuntze Herbarium, and a large part of both the Mitten

Moss and Hepatic Herbarium and the Underwood Hepatic Herbarium.

Six standard herbarium cases, several wall cases, and a book-case were added to the herbarium equipment.

The rapid and uneven accumulation of herbarium material necessitated two general movings of nearly all the herbarium specimens and a temporary arrangement of some herbarium cases.

Assistance and Investigations

Dr. Arthur Hollick, Curator, looked after the development of the collection of fossil plants, and, in connection with the work of determining and labeling the specimens, he prepared and printed several papers on paleobotanical subjects. He continued his studies on the living and extinct flora of Staten Island with special reference to the Cretaceous period, making a complete study of all the local material from Staten Island, Long Island, Block Island, and Martha's Vineyard not previously described. He edited the parts of the BULLETIN of the Garden published during the year, delivered three lectures on the Garden lecture course, and represented the Garden at the Buffalo meeting of the American Association of Museums. Mr. Edwin W. Humphreys continued his voluntary assistance as heretofore, and, in addition, prepared a monograph of the genus *Buthotrephis*.

Dr. Marshall A. Howe, Curator, cared for the collections of algae and hepaticae. He spent the first part of January in the Canal Zone, Panama, in continuation of the explorations mentioned in our last report, giving special attention to the collection of marine algae, and of the lower cryptograms among the land plants. The herbarium work under his direction has resulted during the year in adding about 4,200 mounted sheets, about equally divided between algae and hepatics, to the collections. Dr. Howe also selected over 300 photographic negatives of botanical interest from which enlarged prints for the walls of the Systematic

Museum have been made and he has prepared descriptive labels for a considerable portion of these. He has continued to act as editor of the Torrey Botanical Club, having special charge of its *Bulletin* and *Memoirs*, and has published several reviews in *Torreya*. He has also assisted in the Garden's nature-study work in cooperation with the public schools of the Borough of the Bronx, and delivered three lectures on the regular Garden lecture course.

Dr. William A. Murrill, Assistant Director, has looked after the development and conserving of the collection of fungi. In this work he has had the cooperation of Mr. Fred J. Seaver, Director of the Laboratories. (For further details in this connection, see the reports of the Assistant Director and the Director of the Laboratories.)

Mrs. N. L. Britton continued her voluntary aid in developing the moss collection, particularly in mounting the exotic mosses of the Mitten Herbarium, and has conducted exchanges with various institutions abroad in order to complete, as far as possible, the representation of species in certain genera which are being studied in the preparation of manuscript for NORTH AMERICAN FLORA She has studied critically the genera *Archidium*, *Trematodon*, *Pleuridium*, *Trichodon*, *Ditrichum*, *Saelania*, *Ceratodon*, *Distichium*, *Bryoxiphium*, *Brachyodontium*, and *Seligeria*. She accompanied Dr. Britton in West Indian exploration, and, on the expeditions, she shared in the labor of collecting and preserving specimens in the field.

Mr. R. S. Williams, Assistant Curator during the first half of the year, had charge of the lichen collection and assisted Mrs. Britton in the development of the moss collection. He studied miscellaneous collections of Mexican and West Indian mosses and prepared revisions of the genera *Leucobryum*, *Leucophanes*, *Philopogon*, and *Dicranodontium* for NORTH AMERICAN FLORA.

Dr. P. A. Rydberg, Curator, has attended to the details connected with the herbarium of flowering plants, which this year involved a great deal of sorting and rearranging of specimens. He also separated the Otto Kuntze Herbarium into three parts, namely, duplicates, American plants, and Old World plants. Dr. Rydberg's studies have been confined chiefly to the plants of the Rocky Mountain region, concerning which several papers were published, and the continuation of his monograph of the Rosaceae, which is being printed in NORTH AMERICAN FLORA. His monographs of the Limnanthaceae and Balsaminaceae and a revision of the Zygophyllaceae were published in NORTH AMERICAN FLORA early in the year.

Mr. Norman Taylor, Assistant Curator, helped Dr. Rydberg in caring for the herbarium of flowering plants. He continued his studies in connection with the flora within a radius of one hundred miles of New York City, spending a part of the collecting season in the field, thus securing specimens and making observations for the further study of the subject. Mr. Taylor also gave three lectures on the Garden course and acted as demonstrator in connection with the nature-study courses in cooperation with the public schools of the Borough of the Bronx.

The writer, in addition to the time required on the mechanical and scientific details connected with development and care of the public museums and the herbarium, published a monograph of the Malpighiaceae in NORTH AMERICAN FLORA, prepared a monograph of the North American Simaroubaceae for the same work, and printed minor papers on various botanical subjects. A portion of January and February was spent in exploration on Andros, in the Bahamas. Incidentally, he continued his studies on the flora of the southeastern United States, and particularly on the interrelation of different elements of the flora of the extreme southern part of that region, and their relation to the West Indian flora. He also had many hundred camera-lucida drawings of flower-dissections made on herbarium sheets in order to facilitate current and future studies and monographic work.

Respectfully submitted,
JOHN K. SMALL,
Head Curator of the Museums and Herbarium.

REPORT OF THE HONORARY CURATOR OF THE ECONOMIC COLLECTIONS

Dr. N. L. Britton, Director-in-Chief.

Sir: I have the honor to submit the following report for the year 1910.

The development of the Economic Museum has proceeded steadily throughout the year and the collections exhibit a satisfactory degree of growth and improvement. There has been an addition of 327 specimens, and these are, as a rule, of more than usual value and importance. The more noteworthy additions consist of drug specimens contributed by myself, and of specimens, chiefly of fleshy edible fruits, collected by myself on two journeys into Mexico, one in the late winter and one in the summer. In one of the Garden lectures, an abstract of which is printed in our Journal, I have commented at length on the great interest and importance of a study of the economic plants of Mexico.

Of the drugs referred to, many represent articles of more or less rare or unusual occurrence, while the Mexican fruits are such as scarcely exist in any other collection, and constitute an important supplement to the herbarium specimens of the same species, except in those still more important cases in which this museum material constitutes our only representation of the species. In at least two cases, my museum specimens represent undescribed species of plants, of which all that is known pertains to these specimens. In another instance, a genus is represented of which almost nothing is known, and our museum specimen is probably its best existing representation.

A very showy, and at the same time instructive, contribution is a collection of raisin grapes of southern California. The clusters, borne on leafy twigs and preserved in formaldehyde solution, are of immense size, and are preserved with their natural brilliancy of color but little impaired.

The difficult problem of labeling the Merck collection of plant principles and the Beauregaard collection of varnish resins has been worked out, and both collections will now be found properly labeled.

I have several times referred in these reports to the experiment of supplying explanatory reading matter on the labels of our economic specimens, in addition to the bare outlines of identity and source. Quite a number of such explanatory labels were introduced last year, and some care has been taken to ascertain the reception accorded them by visitors. The result has been most satisfactory. Visitors read and frequently discuss the text of these labels, and turn again to the specimens with renewed interest. I no longer doubt that with the very general distribution of such labels among the collection, the interest in, and the educational value of, our museum will be greatly increased. Such an extension of this method of display has already been taken up and will be vigorously pursued during the coming year.

Conditions at the present time look unusually favorable for large additions of specimens during the coming year, many of them without expense to the Garden, although I take this occasion to reiterate previous statements that the time is at hand when the proper maintenance of this department can be effected only through more liberal appropriations for the purchase of specimens than has heretofore been found necessary.

Inasmuch as I shall probably have another opportunity during the coming year to visit Mexico, without expense to the Garden, I trust that it may be found possible to appropriate the necessary funds to cover the actual cost of making economic collections while there.

Respectfully submitted,

H. H. Rusby,

Honorary Curator of the Economic Collections.

REPORT OF THE DIRECTOR OF THE LABORATORIES

DR. N. L. BRITTON, DIRECTOR-IN-CHIEF.

Sir: I have the honor to submit the following report for the year 1910.

The laboratory equipment has been extended by the addition of several pieces of apparatus to be used in student investigation; and the chemicals, reagents, and general supplies which have been used during the course of such investigations have been replaced.

During the autumn, Dr. W. J. Gies, Consulting Chemist of the Garden, assisted by Dr. E. D. Clark, made use of the chemical laboratory on Wednesday of each week. The work offered at this time consists of a laboratory course in plant chemistry for the benefit of graduate students in Columbia University. The object of this course is to stimulate investigation of original problems in plant chemistry. Some of the chemical problems under investigation are: the chemistry of poisonous mushrooms, the chemistry of soil sterilization and its relation to the growth of plants, and a study of the action of the oxidizing enzymes in plants.

Insect Pests and Plant Diseases

The spraying of the coniferous trees with whale-oil soap solution has been continued as usual. The elm trees in the Garden were sprayed with arsenate of lead, once soon after the leaves unfolded in the spring and again in the early part of June, and the smaller trees were sprayed a third time. During mid-summer, the trees in the Garden which had been sprayed showed much less injury from the attacks of the beetle than those outside of the grounds which had not been treated. Being absent from the city after the middle of August, I was unable to observe conditions, but the spraying was doubtless attended with very satisfactory results.

Numerous cases of diseased plants have been referred to the Garden for examination. In some it was easy to detect the cause of the trouble, while in others the cause was not so evident. More cases of injury from "red spider" have been called to our attention than usual. The prevalence of this insect may have been in part due to the unusually dry season.

Morphological Grounds

The morphological grounds were gone over in the spring and in consultation with the Head Gardener numerous additions were planned, but, owing to the rush of work during the planting season, it became necessary to postpone these additions.

Conference Meetings

A meeting of the conference has been held on the first Wednesday of each month, except in summer. The object of these meetings is to give opportunity to the registered students and members of the staff to offer papers and discussions of problems under investigation. The meetings have been well attended and considerable interest has been shown. A synopsis of the programme offered at each meeting has been published in the JOURNAL.

The subjects treated are: January 5, "Variation in the Non-lobed Sassafras Leaves," by Mr. E. W. Humphreys; "Notes on the genus *Gymnosporangium*," by Mr. F. D. Kern; February 2, "The *Crataegus* Problem," by Mr. W. W. Eggleston; March 2, "The Relationship of the Genera of the Vittarieae," by Mr. R. C. Benedict;" Wisconsin Fungi," by Mr. B. O. Dodge; April 6, "A New Species of Fossil Polypore and a Fossil Alga," by Dr. Arthur Hollick; "The Sterilization of Soil and its Relation to the Growth of *Pyronema*, and other Fungi," by Dr. E. D. Clark; May 4, "The Polyporaceae of Jamaica," by Dr. W. A. Murrill; "The Fungi of Cheese Ripening," by Dr. Charles Thom; "Determination of Fossil Triassic Plants," by Mr. E. W.

Humphreys; November 2, "Specimens of Fossil Figs from the Laramie Formations of Wyoming," by Dr. Arthur Hollick; "The Rusts of Red and White Clover," by Mr. F. D. Kern; "Temperature Factors in the Distribution of our Local Flora," by Mr. Norman Taylor; December 3, "Notes on the Perisporiaceae," by Mr. C. A. Schwarze; "An Addition to the Economic Collections," by Mr. R. C. Benedict, "An Addition to the Triassic Flora of North America," by Mr. E. W. Humphreys.

In addition to the regular outlined programmes, various members of the staff have offered brief notes on subjects of general interest, as noted in the JOURNAL reports.

Meteorological Records

The meteorological records have been kept during the entire year in accordance with the plan previously outlined, and results have been published each month in the Garden JOURNAL. During my absence, the records were made by Mr. R. S. Williams, Administrative Assistant. The summer months were characterized by unusual drought, the details of which were published in the JOURNAL for October.

Personal Investigations

My own investigations have been mainly in continuation of problems previously begun. Investigation of the heating of soil and its relation to the growth of plants has been continued with the cooperation of Dr. E. D. Clark, of the department of biological chemistry of Columbia University. A joint paper has been published as the second of a series, in which we have offered an explanation of the growth of certain fungi on burned-over soil.

Culture work has been continued with other species of microscopic fungi and much information has been gained with reference to the life-histories of certain species which were hitherto not well known.

Some time has been devoted to a revision and extension of my work on the Iowa Discomycetes, and this revision was published in the *Bulletin from the Laboratories of Natural History of the State University of Iowa.* The paper contains ninety-one pages of text and forty-one plates, the text having been entirely revised and sixteen of the plates being new.

The monograph of the North American Hypocreales, including two families, the Nectriaceae and the Hypocreaceae, has been completed for NORTH AMERICAN FLORA. The manuscript of the Fimetariaceae (Sordariaceae) previously published by Dr. David Griffiths has also been worked over and put in form for NORTH AMERICAN FLORA. These three families and the family Chaetomiaceae by Miss H. L. Palliser have been published as volume three, part one, of this work. Work has already been begun on the groups of fungi to appear in the second part of the same volume.

With your permission, I left the city on August 15 for a vacation and collecting trip through Colorado, returning home on the evening of September 30. As a result of this trip, a preliminary account of which appeared in the JOURNAL for November, nine hundred specimens of fungi were added to the Garden collection. While only a small part of this collection has been critically studied, this study has revealed some undescribed species in the groups with which I am most familiar. Also, several species were collected at high altitudes in the Rocky Mountains which were formerly known only from the eastern and northeastern parts of North America, while several were new to North America and others were not represented in the Garden collection. Further study will doubtless furnish still other points of interest. Much time has been spent in a preliminary study of this collection and in preparing the specimens for mounting.

I have also had the oversight of the mounting of specimens, drawings, and notes in that part of the herbarium which includes the ascomycetes and lower fungi.

Students and Investigators

For the past ten years, from 1900 to 1909 inclusive, the number of students and investigators who have been granted the privileges of the Garden has averaged 33 + annually. The maximum was in 1904, when the number reached 46; the minimum was in 1900, when 18 were recorded; the number for the year just ended was 38. The following is a list of students and investigators for 1910:

*ABRAMS, LEROY. A.B., Stanford Univ., 99; A.M., 02; Ph.D., Columbia Univ., 10. Instructor in Botany, Stanford Univ.

A phytogeographic and taxonomic study of the southern California trees and shrubs.

*ANDERSON, MARY PERLE. B.S., Mt. Holyoke, 90; Mass. Inst. Technology, 97–98; Univ. of Chicago, 03–04; N. Y. Bot. Garden, 07–. Teacher of Nature Study, Horace Mann School, Teachers College, Columbia Univ.

Synopsis and distribution of the ferns of Japan.

BANKER, HOWARD JAMES. A.B., Syracuse Univ., 92; A. M., Columbia Univ., 92; Ph.D., 05. Professor of Biology, Depaw Univ.

Mycology; taxonomy of Hydnaceae.

BARRETT, MARY FRANKLIN. B.L., Smith Coll., 01; A.M., Columbia Univ., 05; Woods Hole, 02; Cornell Univ. (summer school), 06; Columbia Univ. (various courses); N. Y. Bot. Garden, 03–06, 09. Instructor in Nature Study, Montclair State Normal School, N. Jersey.

Mycology; Taxonomy of Auriculariceae.

*†BENEDICT, RALPH CURTISS. A.B., Syracuse Univ., 06; Aid, N. Y. Bot. Garden, 06–08; Fellow in Botany, Columbia Univ., 09–10; N. Y. Bot. Garden, 08; Instructor in Botany, Fordham Medical Coll., N. Y. City.

Comparative morphology and classification of ferns.

BRITTON, MRS. N. L. N. Y. City Normal Coll., 75; Hon. Assistant Instructor in Crypt. Botany, Columbia Univ. and Barnard Coll., and unpaid assistant in N. Y. Bot. Garden.

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*Registered at Columbia.

†Research scholarship.

Anatomy and classification of mosses and ferns; Mosses of the West Indies, southern Florida, and Mexico.

BURLINGHAM, GERTRUDE SIMMONS. A.B., Syracuse Univ., 96; Ph.D., Columbia Univ., 08; N. Y. Bot. Garden, 05–. Teacher of Biology, Eastern District H. S., Brooklyn, N. Y.
Mycology; taxonomy of gill-fungi.

*BUTLER, BERTRAM THEODORE. Ph.B., Hamlin Univ., 01; A.M.; Columbia Univ., 08–09; N. Y. Bot. Garden, 07–. City Supt. of Schools and Teacher of Science, Glendive, Montana. Instructor in Botany, Coll. City of N. Y.
Flora of Montana.

CLARK, ERNEST DUNBAR. A.B. (in chemistry), Harvard Univ., 08; A.M., Columbia Univ., 09, Ph.D., 10; John Harvard Scholar, Harvard Univ., 06–07; Assistant in Chemistry, Harvard Univ., 07–08; Research assistant to Professor Alsberg in Physiol. Chemistry, Harvard Medical School; Fellow in Physiol. Chemistry, Columbia Univ., 09–10; Instructor in Biological Chemistry, Columbia Univ., 1910–.
Oxidizing enzymes; chemistry of soil sterilization; plant poisons.

COKER, WILLIAM CHAMBERS. B.S., S. Carolina, 94; Ph.D., Johns Hopkins Univ., 01; Bonn, 01–02; Cold Spring Harbor, 00; N. Y. Bot. Garden, 05, 07, 09. Professor of Botany, State Univ. of N. Carolina.
Flora of North Carolina.

*CORRY, ROBERT THOMAS. Student in combined medical course, Columbia Univ.
Plant chemistry.

*DODGE, BERNARD OGILVIE. Ph.B., Univ. of Wisconsin, 09; Principal of H. S., Algoma, Wisconsin, 02–08. Assistant in Botany, Columbia Univ., 09–.
Mycology; morphology and taxonomy of Ascobolaceae.

EGGLESTON, WILLARD WEBSTER. B.S., Dartmouth, 91; Student, Gray Herbarium, 07; Biltmore Herbarium, 07–08; Aid, N. Y. Bot. Garden, 04–07; Research scholar, 08, 09. Forest Service, U. S. Dept. of Agric.
Taxonomy of Pomaceae and Prunaceae.

FAIRMAN, CHARLES EDWARD. A.B., Rochester, 74; A.M., 77;

M.D., St. Louis Medical Coll., 77. Practising physician, Lyndonville, New York.
Mycology; taxonomy of Lophiostomataceae.

Field, Miss E. C. B.S., Nebraska State Univ. Assistant, bureau plant industry, U. S. Dept. of Agric.
Mycology; parasitic fungi of truck crops.

*Gruenberg, Benjamin Charles. B.S., State Univ. of Minn., 96; A.M., Columbia Univ., 04; N. Y. Univ., 01–02; N. Y. Bot. Garden, 02–06, 08–09. Teacher of Biology, DeWitt Clinton H. S., N. Y. City.
The mycorrhiza problem.

*Hare, Raleigh Frederick. B.S., Alabama Polytechnic Inst., 92; M.S., 93. Professor of Chemistry, N. Mexico Agric. Coll. and chemist to the N. Mexico Exp. Station.
Plant chemistry.

Haynes, Caroline Coventry. N. Y. Bot. Garden, various times, 02–.
Taxonomy of bryophytes.

Hedgcock, George Grant. B.S., Nebraska State Univ., 99; Fellow, A.M., 01; Ph.D., Washington (St. Louis), 06. Pathologist, bureau plant industry, U. S. Dept. of Agric.
Mycology; forest fungi.

Humphreys, Edwin William. A.B., Coll. of the City of New York, 03; A.M., Columbia Univ., 06; N. Y. Bot. Garden, 05–06, and voluntary assistant to Dr. Hollick. Teacher in the Elementary Schools of N. Y. City.
Paleobotany.

†*Kern, Frank Dunn. B.S., Univ. of Iowa, 04; M.S., Purdue Univ., 07; research scholar N. Y. Bot. Garden, 06, 07, 08, 10; fellow in botany Columbia Univ., 10–11. Instructor in Botany, Purdue Univ., and associate, Agric. Exp. Station.
Mycology; morphology and life-history of plant rusts; monograph of the genus Gymnosporangium.

*Liebovitz, Sidney. A.B., Columbia Univ., 09.
Plant chemistry.

Middleton, Florence. Teachers Coll., Columbia Univ., 00–. Teacher of Biology, Wadleigh H. S., N. Y. City.
Mycology; taxonomy of Exobasidiaceae.

MILLSPAUGH, CHARLES FREDERICK. M.D., N. Y. Homeop. Med. Coll., 81; N. Y. Bot. Garden, various times, 03–09; Student in various American and foreign herbaria. Curator, Dept. of Botany, Field Museum of Nat. Hist., Chicago.
Flora of the West Indies.

*ROBINSON, WINIFRED JOSEPHINE. B.S. and Ph.B., State Univ. of Mich., 99; A.M., Columbia Univ., 04; Mich. State Normal Coll., 92; Mich. Agric. Coll., 94; Woods Hole, 99 and 00; N. Y. Bot. Garden, 02–08. Instructor in Botany, Vassar Coll., N. Y.
Taxonomy of ferns.

*ROSE, ANTON RICHARD. B.S., Minn. Univ. Assistant Chemist, N. Y. Agric. Exp. Station.
Plant chemistry.

*SCHWARZE, CARL ALOIS. B.S., Missouri State Univ., 09; Student Assistant in Botany, Missouri State Univ., 08–09.
Mycology, pathology; taxonomy of Perisporaceae.

SLOSSON, MARGARET. N. Y. Bot. Garden, 02–04, 09.
Taxonomy of ferns.

STOVER, WILMER GARFIELD. A.B., Miami Univ. Instructor in Botany, Ohio State Univ.
Mycology; taxonomy of gill-fungi.

†SUMSTINE, DAVID ROSS. A.B., Thiel Coll.; M.S., Univ. of Pittsburg. Research scholar, N. Y. Bot. Garden, 09. Teacher of Biology; Pittsburg H. S.
Mycology; taxonomy of the Mucorales.

THOM, CHARLES. A.B., Lake Forest, 95; A.M., 97; Ph.D., Missouri State Univ., 99. Mycologist in cheese investigation, U. S. Dept. of Agric.
Mycology; taxonomy of Penicillium.

*WILKINS, LEWANNA. B.S., Wellesley Coll., 01; Woods Hole (Wellesley Coll. Table), 96; C. Hart Merriam's Camp, California, summer, 98; Goettingen, Germany, spring and summer, 01; Chicago Univ. (summer school), 07; N. Y. Bot. Garden, 07, 08, 09. Teacher of Biology, Eastern District H. S., Washington, D. C.
Taxonomy of flowering plants.

In addition to the above list, the following party of students was granted the privileges of the tropical laboratory at Cinchona during the months of June and July: Professor Duncan S. Johnson, Messrs. W. H. Brown, A. R. Middleton, L. W. Sharp, and H. H. York, from Johns Hopkins University, and S. H. Derickson, from Lebanon Valley College. The party was engaged in the study of *ecological and cytological problems.*

Respectfully submitted,
FRED J. SEAVER,
Director of the Laboratories.

REPORT OF THE LIBRARIAN

DR. N. L. BRITTON, DIRECTOR-IN-CHIEF.

Sir: I have the honor to submit the following report for the year 1910.

The annual census of the library shows that the present number of bound volumes is 22,939, an increase of 1,231 volumes during the year. Lists of accessions have been published from time to time in the Garden JOURNAL, as usual; among these have been 46 volumes received as gifts.

The Librarian spent the months of May, June, and July in Europe, his chief mission being the purchase of books for the library; nearly all the books added this year on the account of the special book fund, numbering in all 964 bound volumes and 1,138 pamphlets, were secured during this trip. The number of books bound this year in 469; of these, 71 are the property of Columbia University, on deposit at the Garden. The appended list enumerates the serial publications currently received by the library.

The most complete bibliography of botanical literature, although it is now nearly forty years old, is the second edition of Pritzel's *Thesaurus*. This has been used as a handbook in our library ever since its establishment, and a persistent effort has been made, while not neglecting the newer literature, to complete the representation of the older literature as recorded by Pritzel. The entries in the *Thesaurus* are numbered, there being 10,871 in all; in many instances a "number" represents a mere pamphlet of a few pages or even a single page, while in other cases it represents a large set of volumes or various editions of the same work, so that a Pritzel "number" is nothing very definite. Yet it may furnish some idea of the field still open to us in our attempt to complete our representation of the older literature, to mention that of these numbers almost exactly one half are still wholly unrepresented in our library, and this in spite of the fact that we now have 600 (or about five and one half per cent.) more than a year ago. Many of the gaps could be filled easily; the purchases of the past summer were limited only by the exhaustion of the available fund.

The crowded condition of the library, as a result of its normal growth, necessitates immediate provision for increased accommodation. In the room to the west of the reading-room, now forming a part of the library, can be placed conveniently book-stacks to provide about 2,500 linear feet of shelving, of which less than ten per cent. is now installed. The remainder should be purchased and put in place as rapidly as funds available for equipment will permit.

In May, the writer represented the Garden at the International Botanical Congress in Brussels, and later took the opportunity of studying many types of Lentibulariaceae at Munich, Berlin, Paris, London, and Kew. The small family Koeberliniaceae has been contributed to NORTH AMERICAN FLORA.

Respectfully submitted,
JOHN HENDLEY BARNHART,
Librarian.

LIST OF PERIODICALS

*Periodicals subscribed for by the Garden.

†Periodicals subscribed for by Columbia University and deposited at the Garden.

‡Periodicals received in exchange by the Torrey Botanical Club and deposited at the Garden.

All others are received in exchange by the Garden.

*Académie Internationale de Géographie Botanique, Le Mans, France. *Bulletin.*

Agricultural Experiment Station, Auburn, Ala.
" " " Tuskegee, Ala.
" " " Uniontown, Ala.
" " " Tucson, Ariz.
" " " Fayetteville, Ark.

Agricultural Experiment Station, Berkeley, Calif.
“ “ “ Fort Collins, Colo.
“ “ “ New Haven, Conn.
“ “ “ Storrs, Conn.
“ “ “ Newark, Del.
“ “ “ Gainesville, Fla.
“ “ “ Experiment, Ga.
“ “ “ Honolulu, Hawaii.
“ “ “ Moscow, Idaho.
“ “ “ Urbana, Ill.
“ “ “ Lafayette, Ind.
“ “ “ Ames, Iowa.
“ “ “ Manhattan, Kan.
“ “ “ Lexington, Ky.
“ “ “ Baton Rouge, La.
“ “ “ Orono, Me.
“ “ “ College Park, Md.
“ “ “ Amherst, Mass.
“ “ “ Agricultural College, Mich.
“ “ “ St. Anthony Park, St. Paul, Minn.
“ “ “ Agricultural College, Miss.
“ “ “ Columbia, Mo.
“ “ “ Bozeman, Mont.
“ “ “ Lincoln, Neb.
“ “ “ Reno, Nev.
“ “ “ Durham, N. H.
“ “ “ New Brunswick, N. J.
“ “ “ Mesilla Park, N. Mex.
“ “ “ Geneva, N. Y.
“ “ “ Ithaca, N. Y.
“ “ “ Raleigh, N. C.
“ “ “ Fargo, N. D.
“ “ “ Wooster, Ohio.
“ “ “ Stillwater, Okla.
“ “ “ Corvallis, Oregon.
“ “ “ State College, Pa.
“ “ “ Mayaguez, Porto Rico, W. I.
“ “ “ Kingston, R. I.
“ “ “ Clemson College, S. C.

Agricultural Experiment Station, Brookings, S. Dak.
“ “ “ Knoxville, Tenn.
“ “ “ College Station, Texas.
“ “ “ Logan, Utah.
“ “ “ Burlington, Vt.
“ “ “ Blacksburg, Va.
“ “ “ Morgantown, W. Va.
“ “ “ Pullman, Wash.
“ “ “ Madison, Wis.
“ “ “ Laramie, Wyo.
Agricultural Gazette of New South Wales, Sydney, N. S. W.
Agricultural Journal of India, Calcutta, India.
Agricultural Ledger, Calcutta, India.
Alabama. Geological Survey of Alabama, University, Ala. *Bulletin*, *Report.*
†Allgemeine Botanische Zeitschrift, Karlsruhe, Germany.
Alumni Journal, College of Pharmacy, New York, N. Y.
Amani. Biologisch-Landwirtschaftliches Institut, Bezirk Tanga, Deutsch-Ost-Afrika. *Berichte.*
America. Botanical Society of America. *Publications.*
America. Society of American Florists, Boston, Mass. *Proceedings.*
American Academy of Arts and Sciences, Boston, Mass. *Proceedings.*
American Agriculturist, New York, N. Y.
American Association for the Advancement of Science, Washington, D. C. *Proceedings.*
*American Botanist, Joliet, Ill.
American Florist, Chicago, Ill.
American Forestry, Washington, D. C.
*American Homes and Gardens, New York, N. Y.
American Journal of Pharmacy, Philadelphia, Pa.
American Journal of Science, New Haven, Conn.
‡American Midland Naturalist, Notre Dame, Ind.
American Museum of Natural History, New York, N. Y. *Bulletin*, *Report.*
‡American Naturalist, Boston, Mass.
American Philosophical Society, Philadelphia, Pa. *Proceedings.*
American Review of Tropical Agriculture, Mexico City, Mexico.
American Rose Society, New York, N. Y. *Bulletin.*

†Annales des Sciences Naturelles : Botanique ; Paris, France.
Annales Mycologici, Berlin, Germany.
Annali di Botanica: see Rome, R. Istituto Botanico.
†Annals of Botany, London, England.
Antwerp. Jardin Botanique, Antwerp, Belgium. *Seed Lists.*
Appalachian Mountain Club, Boston, Mass. *Appalachia.*
Arboriculture : see International Society of Arboriculture.
*Archiv der Pharmazie, Berlin, Germany.
*Archiv für Zellforschung, Leipzig, Germany.
Ardennes. Société d'Histoire Naturelle, Charleville, France. *Bulletin.*
Argentine Republic. Museo de La Plata, Argentina. *Anales.*
Argentine Republic. Sociedad Cientifica Argentina, Buenos Aires, Argentina. *Anales.*
Arkiv för Botanik : see Sweden, Kongliga Svenska Vetenskaps-Akademien.
Asiatic Society of Bengal : see Bengal, Asiatic Society.
Asmara. Ufficio Agrario Sperimentale, Asmara, Colonia Eritrea, N. E. Africa. *L'Agricoltura Coloniale.*
*Association Française pour l'Avancement des Sciences, Paris, France. *Compte Rendu.*
Association pour la Protection des Plantes, Geneva, Switzerland. *Bulletin.*
Audubon Park: see New Orleans.
Augsburg. Naturwissenschaftlichen Vereins für Schwaben und Neuburg (a.V.) früher Naturhistorischen Vereins in Augsburg, Augsburg, Germany. *Bericht.*
Bahama Islands. Agricultural Department, Nassau, N. P., Bahamas. *Bulletin.*
Bambou: see Le Bambou.
Basel. Naturforschende Gesellschaft, Basel, Switzerland. *Verhandlungen.*
Belize. Botanical Garden, Belize, British Honduras, Central America.
Bengal. Asiatic Society of Bengal, Calcutta, India. *Journal.*
Bergianska Trädgården, Stockholm, Sweden. *Acta Horti Bergiani.*
‡Berlin. Königlicher Botanischer Garten, Berlin, Germany. *Notizblatt.*
Bermuda. Report of the Board of Agriculture, Bermuda, W. I.

Bernice Pauahi Bishop Museum, Honolulu, Hawaii.

†Bibliotheca Botanica, Stuttgart, Germany.

*Biltmore Botanical Studies, Biltmore, N. C.

*Biologisches Centralblatt, Leipzig, Germany.

*Biometrika, London, England.

Bombay. Victoria Gardens, Bombay, India. *Report.*

Boston. Board of Commissioners of Department of Parks, Jamaica Plain, Mass. *Annual Report.*

Boston. Board of Metropolitan Park Commissioners, Boston, Mass. *Report.*

‡Boston Society of Natural History, Boston, Mass. *Proceedings.*

Botanical Gazette, Chicago, Ill.

†Botanical Magazine, London, England.

Botanical Society of America: see America, Botanical Society.

†Botanische Jahrbücher, Leipzig, Germany.

†Botanische Zeitung, Leipzig, Germany.

†Botanischer Jahresbericht, Leipzig, Germany.

†Botanisches Centralblatt, Cassel, Germany.

†Botanisches Centralblatt, Beihefte, Cassel, Germany.

‡Botanisk Tidsskrift: see Copenhagen, Société Botanique.

Botaniste: see Le Botaniste.

‡Botaniska Notiser, Lund, Sweden.

Brandenburg. Botanischer Verein der Provinz Brandenburg, Berlin, Germany. *Verhandlungen.*

Braunschweig. Herzoglicher Botanischer Garten, Brunswick, Germany. *Seed Lists.*

Bremen. Naturwissenschaftlicher Verein, Bremen, Germany. *Abhandlungen.*

*British Mycological Society, Worcester, England. *Transactions.*

Brooklyn Institute of Arts and Sciences, Brooklyn, N. Y. *Report*, *Memoirs of Natural Science*, *Science Bulletin*, *Museum News*, *Cold Spring Harbor Monographs.*

Broteria: Revista de Sciencias Naturaes do Collegio de S. Fiel, Lisbon, Portugal.

Brussels. Institut Botanique de l'Université, Brussels, Belgium. *Recueil.*

Brussels. Jardin Botanique de l'État, Brussels, Belgium. *Bulletin.*

Bryologist, Brooklyn, N. Y.

Bucharest. Institut Botanique, Bucharest, Roumania. *Bulletin de l' Herbier.*

Budapest. Hortus Botanicus Universitatis Budapestinensis, Budapest, Hungary. *Seed Lists.*

Buenos Aires. Jardin Botanico Municipal de Buenos Aires, Buenos Aires, Argentine Republic. *Seed Lists.*

Buenos Aires. Museo de Farmacologia, Buenos Aires, Argentine Republic. *Trabajos.*

Buenos Aires. Museo Nacional, Buenos Aires, Argentine Republic. *Anales.*

Buffalo Botanic Garden, West Seneca, N. Y.

Buffalo Park Commissioners, Buffalo, N. Y. *Annual Report.*

Buffalo Society of Natural Sciences, Buffalo, N. Y. *Bulletin.*

*Buitenzorg. Jardin Botanique, Buitenzorg, Java. *Annales.*

Buitenzorg. Jardin Botanique, Buitenzorg, Java. *Bulletin*, *Mededeelingen*, *Verslag*, *Icones Bogorienses.*

*Bulletin du Jardin Colonial et des Jardins d'Essai des Colonies Françaises, Paris, France.

Bulletin of Pharmacy, Detroit, Mich.

Calcutta. Indian Museum, Calcutta, India. *Indian Museum Notes.*

‡Calcutta. Royal Botanic Gardens, Calcutta, India. *Annals.*

California Academy of Sciences, San Francisco, Calif. *Proceedings.*

California State Agricultural Society, Sacramento, Calif. *Transactions.*

California State Board of Horticulture, Sacramento, Calif. *Report.*

California. University of California, Berkeley, Calif. *Publications in Botany.*

Canada. Botanical Club of Canada, Halifax, Canada. *Annual Report.*

Canada. Geological and Natural History Survey, Ottawa, Canada. *Contributions from the Herbarium.*

Canada. Report of the Minister of Agriculture, Ottawa, Canada.

‡Canadian Record of Science, Montreal, Canada.

Carnegie Institution of Washington: Desert Botanical Laboratory, Tucson, Arizona.

Carnegie Institution of Washington: Station for Experimental Evolution, Cold Spring Harbor, N. Y. *Papers*, *Report.*

Carnegie Museum, Pittsburg, Pa. *Annals*, *Annual Report*, *Memoirs.*

Catania. Hortus Botanicus Regiae Universitatis Catinensis, Catania, Italy. *Seed Lists.*

Cellule: see La Cellule.

*Centralblatt für Bakteriologie: Abtheilung I, Jena, Germany.

*Centralblatt für Bakteriologie: Abtheilung II, Jena, Germany.

Charleston. College of Charleston Museum, Charleston, S. C. *Bulletin.*

Chicago Academy of Sciences, Chicago, Ill. *Bulletin*, *Bulletin of the Natural History Survey*, *Special Publication.*

Chicago. University of Chicago, Chicago, Ill. *Contributions from the Hull Botanical Laboratory.*

Chile. Museo Nacional, Santiago de Chile, Chile. *Anales.*

Christiania. Hortus Botanicus, Christiania, Norway. *Seed Lists.*

Christiania. Physiographiske Forening, Christiania, Norway. *Nyt Magazin for Naturvidenskaberne.*

Christiana. Videnskabs-Selskabet, Christiania, Norway. *Skrifter.*

Cincinnati. Botanical Gardens, Cincinnati, Ohio.

Cincinnati Society of Natural History, Cincinnati, Ohio. *Journal.*

Clara Leigh Dwight Gardens, Mount Holyoke College, Mass. *Seed Lists.*

Cold Spring Harbor Monographs: see Brooklyn Institute of Arts and Sciences.

Cologne. Botanischer Garten der Stadt Cöln, Cologne, Germany. *Seed Lists.*

Colombia. Ministerio de Obras Publicas y Fomento, Bogota, Colombia. *Revista.*

Colorado College Studies, Colorado Springs, Colo.

Colorado State Board of Agriculture, Denver, Colo. *Annual Report.*

Colorado. University of Colorado, Boulder, Colo. *Studies.*

Columbia University, New York, N. Y. *Contributions from the Department of Botany*, *Memoirs of the Department of Botany*, *Contributions from the Department of Geology.*

‡Columbus Horticultural Society, Columbus, Ohio. *Journal.*

Connecticut Academy of Arts and Sciences, New Haven, Conn. *Transactions.*

Connecticut. Geological and Natural History Survey, Hartford, Conn. *Bulletin.*

Connecticut State Board of Agriculture, Hartford, Conn. *Annual Report.*

Copenhagen. Botanic Gardens, Copenhagen, Denmark. *Arbejder.*

‡ Copenhagen. Société Botanique, Copenhagen, Denmark. *Botanisk Tidsskrift.*

Costa Rica. Sociedad Nacional de Agricultura, San José de Costa Rica. *Boletin.*

* Country Life in America, New York, N. Y.

Cracow. Académie des Sciences de Cracovie, Cracow, Austria. *Bulletin International*, *Catalogue of Polish Scientific Literature.*

Cuba. Estación Central Agronómica, Santiago de las Vegas, Cuba, W. I. *Bulletin*, *Circular*, *Report.*

Cuba Review, New York, N. Y.

Curtis' Botanical Magazine: see Botanical Magazine.

Davenport Academy of Sciences, Davenport, Ia. *Proceedings.*

Delaware County Institute of Science, Media, Pa. *Proceedings.*

Denison University, Granville, O. *Bulletin of the Scientific Laboratories.*

Desert Botanical Laboratory: see Carnegie Institution, Desert Botanical Laboratory.

Detroit. Commissioner of Parks and Boulevards, Detroit, Mich. *Annual Report.*

† Deutsche Botanische Gesellschaft, Berlin, Germany. *Berichte.*

Deutsche Dendrologische Gesellschaft, Poppelsdorf bei Bonn, Germany. *Mitteilungen.*

Dorpat: see Jurjeff.

Dublany. Hortus Botanicus Academicus: see Lemberg, Hortus Botanicus.

Dublin. Royal Botanic Gardens, Glasnevin, Dublin, Ireland. *Seed Lists.*

‡ Edinburgh Botanical Society, Edinburgh, Scotland. *Transactions.*

Edinburgh. Royal Botanic Garden, Edinburgh, Scotland. *Seed Lists.*

Eli Lilly and Company, Indianapolis, Ind.

Elisha Mitchell Scientific Society, Chapel Hill, N. C. *Journal.*

Eritrea: see Asmara.

Fauna: see Luxemburg, Société des Naturalistes Luxembourgeois.

*Fern Bulletin, Joliet, Ill.

Feuille des Jeunes Naturalistes, Paris, France.

Field Museum of Natural History, Chicago, Ill. *Publications: Botanical Series, Report Series.*

†Flora, Marburg, Germany.

Florence. R. Orto Botanico, Florence, Italy. *Lavoria.*

Florida. Report of the Commissioner of Agriculture, Jacksonville, Florida.

Florida State Horticultural Society, Jacksonville, Fla. *Proceedings.*

Florist's Exchange, New York, N. Y.

Flower Preservation Society of America, Washington, D. C. *Circulars.*

Forest and Stream, New York, N. Y.

Forest, Fish and Game, Athens, Ga.

Forestry Quarterly, Toronto, Ont.

†France. Société Botanique de France, Paris, France. *Bulletin.*

France. Société Dendrologique de France, Paris, France. *Bulletin.*

†France. Société Mycologique de France, Paris, France. *Bulletin.*

Frankfort on Main. Senckenbergische Naturforschende Gesellschaft, Frankfurt a/M., Germany. *Berichte.*

‡Frankfort on Oder. Naturwissenschaftlicher Verein des Regierungsbezirkes, Frankfurt a/O., Germany. *Helios.*

†Garden, London, England.

Garden Magazine, New York, N. Y.

†Gardener's Chronicle, London, England.

Gardener's Chronicle of America, Jersey City, N. J.

Gardening, Chicago, Ill.

*Gartenflora, Munich, Bavaria, Germany.

Gartenkunst, Berlin, Germany.

Geneva. Jardin d'Acclimatation Alpin, Genève, Switzerland. *Seed Lists.*

Geneva. Jardin Botanique de Genève, Genève, Switzerland. *Annuaire.*

Geneva. Société Botanique de Genève, Genève, Switzerland. *Bulletin.*

Geneva. Université de Genève, Laboratoire de Botanique, Genève, Switzerland. *Etudes.*

Georgia State Horticultural Society, Augusta, Ga. *Proceedings.*

Gera. Gesellschaft von Freunden der Naturwissenschaften in Gera, Gera, Germany. *Jahresbericht.*

Gray Herbarium: see Harvard University.

Grenoble. Jardin des Plantes de la Ville de Grenoble, Grenoble, France. *Seed Lists.*

Grenoble. Université de Grenoble, Jardins Botaniques Alpins, Grenoble, France. *Seed Lists.*

Groningen. Jardin Botanique de l'Université, Groningen, Holland. *Seed Lists.*

Gulf Biologic Station, Cameron, La. *Bulletin.*

Hamburg. Naturwissenschaftlicher Verein, Hamburg, Germany. *Verhandlungen, Botanical papers from the Abhandlungen.*

Hamburgische Botanische Staatsinstitute, Hamburg, Germany. *Seed Lists.*

Hamilton Scientific Association, Hamilton, Ontario. *Journal and Proceedings.*

Hardwood Record, Chicago, Ill.

Harlem. Kolonial Museum te Haarlem, Haarlem, Holland. *Bulletin.*

Hartley Botanical Laboratories: University of Liverpool, Liverpool, England. *Publications and Reprints.*

Harvard University, Cambridge, Mass. *Contributions from the Gray Herbarium, Contributions from the Cryptogamic Laboratory, Contributions from the Phanerogamic Laboratory.*

Havana. Academia de Ciencias Médicas, Fisicas y Naturales de la Habana. Havana, Cuba. *Anales.*

Havana. Jardin Botanico de la Universidad, Havana, Cuba.

Havana. Universidad de la Habana, Havana, Cuba. *Revista de la Facultad de Letras y Ciencias.*

Hawaii. Sugar Planter's Association Experiment Station, Honolulu, Hawaii. *Report, Bulletin.*

Hawaiian Forester and Agriculturist, Honolulu, Hawaii.

‡Hedwigia, Dresden, Germany.

Helios; see Frankfort on Oder, Naturwissenchaftlicher Verein.

Helsingfors: Universitetes Botaniska Institution, Helsingfors, Finland. *Miscellaneous botanical reprints and papers.*

Hérault. Société d'Horticulture et d'Histoire Naturelle de l'Hérault, Montpelier, France. *Annales.*

Holland. Société Botanique Néerlandaise, Nijmegen, Holland. *Nederlandsch Kruidkundig Archief, Recueil des Travaux botaniques Néerlandais.*

Hooker's Icones Plantarum: see Icones Plantarum.

Horticulture, Boston, Mass.

Hortus Thenesis: see Tirlemont.

House and Garden, Philadelphia, Pa.

Household Journal and Floral Life, Springfield, O.

Howard Memorial Library, New Orleans, La.

Hull Botanical Laboratory: see Chicago University.

Hungary. Institut Central Ampélologique Royal Hongrois, Budapest, Hungary. *Annales.*

‡ Icones Plantarum, London, England.

Icones Selectae Horti Thenensis: see Tirlemont.

Illinois Farmer's Institute, Springfield, Ill. *Annual Report.*

Illinois State Department of Agriculture, Springfield, Ill. *Transactions.*

Illinois State Laboratory of Natural History, Urbana, Ill. *Bulletin.*

India. Botanical Survey of India, Calcutta, India. *Records.*

India. Department of Agriculture in India, Pusa, India. *Memoirs.*

India. Imperial Department of Agriculture, Calcutta, India. *Annual Report.*

India Rubber World, New York, N. Y.

Indian Museum Notes: see Calcutta, Indian Museum.

Indiana Academy of Science, Indianapolis, Ind. *Proceedings.*

Indiana Horticultural Society, Indianapolis, Ind. *Transactions.*

* International Catalogue of Scientific Literature: Botany, London, England.

International Society of Arboriculture, Connersville, Ind. *Arboriculture.*

Iowa Academy of Sciences, Des Moines, Ia. *Proceedings.*

Iowa Department of Agriculture, Des Moines, Ia. *Yearbook.*

Iowa Naturalist, Iowa City, Ia.

Iowa Park and Forestry Association, Iowa City, Ia. *Proceedings.*

Iowa State College of Agriculture and Mechanic Arts, Ames, Ia. *Contributions from the Botanical Department.*

Iowa State Horticultural Society, Des Moines, Ia. *Transactions.*

Iowa State University, Iowa City, Ia. *Bulletin of the Natural History Laboratories.*

‡Italy. Società Botanica Italiana, Florence, Italy. *Bullettino, Nuovo Giornale Botanico Italiano, Bullettino Bibliografico.*

†Jahrbücher für Wissenschaftliche Botanik, Leipzig, Germany.

*Jahresbericht der Vereinigung der Vertreter der Angewandten Botanik, Berlin, Germany.

Jahresbericht über das Gebiet der Pflanzenkrankheiten, Berlin, Germany.

†Jahresbericht über die Fortschritte in der Lehre von den Pathogenen Mikroorganismen, Leipzig, Germany.

Jamaica. Department of Agriculture, Hope, Kingston, Jamaica. *Bulletin.*

Japan. Imperial Central Agricultural Experiment Station, Tokio, Japan. *Bulletin.*

Jardin Colonial: see Bulletin du Jardin Colonial et des Jardins d'Essai des Colonies Françaises.

Java. Proefstation voor Suikerriet in West Java, Dutch East Indies. *Mededeelingen.*

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REPORT OF THE SUPERINTENDENT OF GROUNDS

Dr. N. L. Britton, Director-in-Chief.

Sir: I have the honor to submit the following report for the year 1910.

Regulating and Grading

Considerable work of this class has been done, especially in the northern part of the Garden. Early in spring, after the frost was out of the ground, the paths east and west of the main driveway were surfaced and the water pipe put underground north of the Scott Avenue Bridge, the grass gutters between the road and paths were brought to grade with top soil to the Upper Bridge, west of the road about a thousand square feet and east of the road about half an acre were graded and regulated, the edge of paths and roads sodded, and these areas sown and trees and shrubs planted. The portion of the slope left unfinished in 1909 east of the Upper Bridge, 309 feet in length and 30 feet in width, has been regulated, covered with top soil, and sown. The surplus earth obtained from that part, about a thousand cubic yards, was used to grade the eastern meadows north of the cross path and the surplus earth left by the contractor building the retaining wall of the Eastern Boulevard has been used to fill in the area south of the cross path.

The newly laid drain pipe has been safely covered to guard it from freezing, the path line west and parallel with the river-road and a part of the sunken meadows have been filled to grade, about 1,500 cubic yards having been used to make said fill. The northeast corner of the Garden north of the curve of the river road and also between the retaining wall and the road, a space of 470 square yards, has been regulated, surfaced with good soil, and graded. A portion of the quarry area northwest of the museum building, measuring 125 by 200 feet, was graded and sown, a total of 1,965 cart loads of stone and earth being required to complete this work.

The grading of the grounds and excavation for the cellar and foundations for the additional greenhouses now under construction has been partly completed, 700 cubic feet of stone and earth having been removed and used to regulate the grounds and paths southwest of said houses. Considerable grading has been done elsewhere in that vicinity along existing and new paths and roads. The record shows that 5,762 cubic yards of earth, 2,830 cubic yards of stone, 302 yards of screenings, 138 team loads of boulders, and 100 loads of rubbish were hauled and disposed of during the year, making a total of 9,132 cubic yards.

Drainage

Much work of this kind has been done, especially in the north meadows west and east of the Bronx River. In underground drainage, we have laid a line of ten and twelve inch sewer-pipe measuring 528 feet from the low point of the upper meadows east of the river draining south into the river; with which line 200 feet of twelve-inch pipe draining the old creek, and 20 feet of twelve-inch pipe taking the waste water from Power House No. 2 and surroundings, have been connected.

In the valley opposite the curve of the river road, 350 feet of eight-inch pipe was laid to connect the drain previously constructed, draining the water of the new conservatories and eight catch-basins, of which four have been newly constructed, to a culvert emptying into the river; also 168 feet of six-inch pipe has been laid to drain said basins.

The twelve-inch pipe draining the eastern grounds near the stable has been extended 200 feet, from the southeast corner of the Long Bridge to the small lily pond north of the foot bridge; also 50 feet of three-inch pipe has been used to drain a drinking fountain in the vicinity.

A catch-basin has been built and 150 feet of twelve-inch pipe laid to drain the low grounds north of Scott Avenue Bridge Approach. On the west side of the main driveway, between the museum building and the lakes, a six-inch pipe drain has been laid extending 264 feet, and 3 catch-basins have been constructed, the grass gutter being lowered to its original grade. There have been 4 catch-basins constructed east of the Long Bridge along the path leading north.

During the year 17 catch-basins and 2 dry wells were constructed.

Roads and Paths

The remaining part of the new road from near the stable to the southeastern end of the Garden has been entirely paved and nearly covered with trap rock; and a service road 225 feet in length and 12 feet in width has been constructed to connect the above road with the propagating houses. A twelve foot road 350 feet in length from the barnyard to the entrance of the nursery has been constructed and is now ready for surfacing.

The service road on the south border and the driveway east of the river have been resurfaced, rolled, and put in good condition by the Department of Parks.

The 2,335 feet of path under construction at the end of 1909 have been nearly all completed and opened to the public. The path west of the river road in the meadows has been extended 200 feet, while north and west of said road paths measuring 300 feet have been graded and partly paved.

The path under construction in 1909 beginning on the hillside east of the Long Bridge and leading in a northerly direction, measuring 540 feet, has been surfaced and entirely completed. A branch line to the entrance of the newly constructed conservatories has been graded and line stones laid.

A path 500 feet in length, beginning at Lake No. 3 and leading in a northerly direction beneath the west arch of the Long Bridge and along the low grounds adjoining the river, has been filled to grade, mostly with ashes, paved and completed, and opened to the public.

New work was laid out after the fill was completed south of the cross path leading to the chestnut bridge, and east of the river road along the retaining wall of the Bronx Boulevard. About 700 feet of new paths were graded and partly paved in this vicinity. Also 350 feet in the woods east of the economic garden and 100 feet east of the herbaceous grounds were completely constructed. The paths at the eastern entrance (Bleecker Street), measuring about 700 feet, have been paved but not surfaced with screenings. Many of the existing paths have been resurfaced and rolled.

PATHS COMPLETED AND OPENED DURING THE YEAR

	FEET
Over the northern bridge and curving south	900
Over the chestnut bridge and west of bridge leading north...	1,100
Northwest of museum building................	520
On low grounds west of river..................	840
East of the long bridge along the hillside to valley and up valley to new conservatories........	590
In the woods opposite the economic garden......	156
Connecting herbaceous grounds with wood road...	200
	4,306

Extension of Water Supply

The six-inch main laid previously to a point about 250 feet north of the Lake Bridge and west of the main driveway through the Fruticetum has been extended to the north end of the Garden, and thence along the river road to the plaza east of the Long Bridge, where it was connected with the six-inch line supplying the buildings and grounds east of the Bronx River. This required 3,900 line feet of pipe and 43 hose-taps. The work was begun in February and completed in June. A branch line 348 feet in length was later constructed parallel with the new road near the stable. One fire hydrant and 4 hose-taps were connected with this main. In December, we received 800 feet of six-inch water pipe for continuing this extension.

Guard Rails

Additional guard rail made of one-inch galvanized pipe has been erected, as follows: along the edge of a path in the Fruticetum, 270 feet; east and west of the main driveway near the lakes, 144 feet; on the path around the middle lake, 600 feet; on the edge of the woods south of the lake from the main road to the Boulder Bridge, 588 feet; and along a path and on the edge of the woods in the Herbaceous Grounds, 344 feet. Of this, 1,014 feet were constructed of one rail, and 932 feet of two rails, the posts being 6 feet apart.

Buildings

Conservatory Range No. 1 has required considerable repairing, and the entire exterior of the building has been painted. The propagating houses required only minor repairs on ventilators and doors and the exterior of all the houses were painted. The plumbing of the public comfort stations required a complete overhauling before they were opened in April. Only minor repairs were required in the barn. Small repairs have been made on carts and machinery; and one new horse, one farm wagon, and two carts were purchased. The expenditure for horse feed has been $1114.64 during the year. The hay crop was considerably less than in previous years, owing to the dry season and the improvements made on the meadows.

Grounds

Police protection furnished by the City was the same as in former years, one officer being regularly detailed to patrol the Garden, except on special occasions such as lectures for school children, when an extra patrolman was supplied on request, for a few hours at a time.

Owing to the vigilance of our special guards and our system of having employees guard the herbaceous grounds and fruticetum until a late hour, very little damage has been done.

According to records kept by Elevated Railway employees, 36,000 visitors passed over the Elevated Approach on Sunday, July 10, which was the maximum number recorded for the year.

The recently constructed iron fence along the south boundary line of the grounds has been painted and all the low iron-pipe fences have received one coat of paint.

The catch-basins, drains, swamps, lakes, and ponds have been regularly inspected, cleaned, and treated with kerosene for mosquitoes and copper sulphate for algae when it became necessary.

Respectfully submitted,
F. A. Schilling,
Superintendent of Grounds.

SCHEDULE OF EXPENDITURES DURING THE YEAR 1910, UNDER APPROPRIATIONS

1. City Maintenance Account $82,994.64

Salaries and Wages

Appropriated	64,860.00
Expended	64,855.35
Balance	4.65

General Supplies

Appropriated	2,000.00
Transferred from Fuel	500.00
	2,500.00
Expended	2,494.80
Balance	5.20

Materials for Repairs and Replacement by Departmental Labor

Appropriated	1,000.00
Transferred from Apparatus, Machinery, etc.	250.00
	1,250.00
Expended	1,249.98
Balance	.02

Repairs and Replacements by Contract or Open Order

Appropriated	500.00
Transferred from Fuel	200.00
	700.00
Expended	687.74
Balance	12.26

Fuel

Appropriated		12,000.00
Expended through Park Department contracts for coal	10,158.00	
Expended by N. Y. Botanical Garden	1,131.04	
	11,289.04	

Transferred to General Supplies	500.00		
Transferred to Repairs and Replacements	200.00	700.00	11,989.04
Balance			10.96

Contingencies

Appropriated	495.00
Expended	493.52
Balance	1.48

Telephone Service

Appropriated	100.00
Expended	95.43
Balance	4.57

Forage, Shoeing and Boarding Horses

Appropriated	1,114.64
Expended	1,103.98
Balance	10.66

Apparatus, Machinery, Vehicles, Harness, etc., including Care and Storage

Appropriated		925.00	
Expended	666.48		
Transferred to Materials for Repairs	250.00	916.48	
Balance		8.52	
Total expended			82,936.32
Balance			58.32

2. CONSTRUCTION AND EQUIPMENT

Old Account

January 10, Balance	20,801.13	
Premiums on Bonds	208.69	
To adjust difference on open market order	7.50	21,017.32
Expended, through Park Department, miscellaneous contracts	5,900.14	
Open market orders	610.47	
Engineer's pay rolls	374.19	
	6,884.80	

Expended, by New York Botanical Garden.		
Salaries and labor	11,988.27	
Total Expended		18,873.07
		2,114.25
Less—Contract Liabilities	1,832.25	
Open market orders	270.00	2,102.25
Available balance		42.00

New Account

July 19, New Appropriation		42,050.00
Expended, through Park department, open market orders	590.26	
Expended, by New York Botanical Garden.		
Salaries and labor	2.647.68	
Total expended		3,237.94
		38,812,06
Less—Contract liabilities		24,972.00
Available balance		13,840.06

3. GARDEN ACCOUNTS

Assistance for Treasurer

Appropriated	180.00
Expended	180.00

Contribution to Maintenance, to Supplement City Appropriation	12,930.00	
Refund	1.00	
Transferred from Publications	500.00	
Transferred from Exploration and Collecting	600.00	
Transferred from Laboratories	100.00	14,131.00

Addition to Salaries

Appropriated		1,020.00
Expended	937.50	
Inter-transfer to Special Assistance	60.00	997.50
Balance		22.50

Special Assistance

Appropriated		1,450.00
Transferred from Publications		500.00
Inter-transfer from Laborers and Gardeners		316.34
Inter-transfer from Additions to Salaries		60.00
		2,326.34
Expended		2,316.34
Balance		10.00

Laborers and Gardeners

Appropriated		8,960.00
Transferred from Exploration and Collecting		600.00
Transferred from Laboratories		100.00
		9,660.00
Expended	8,642.76	
Inter-transfer to Special Assistance	316.34	
Inter-transfer to Supplies	700.90	9,660.00

Supplies

Appropriated	1,500.00	
Refund	1.00	
Inter-transfer from Laborers and Gardeners	700.90	
	2,201.90	
Expended	2,196.38	
Balance	5.52	
Total expended		14,092.98
Balance		38.02

Circular for Membership

Appropriated	200.00
Transferred from Horticultural Prizes	15.00
	215.00
Expended	213.11
Balance	1.89

Contingent Fund

Appropriated	800.00
Transferred from Museums and Herbarium.	125.00
	925.00
Expended	924.70
Balance	30

Docent

Special Appropriation		720.00
Expended		720.00

Exploration and Collecting

Appropriated		1,000.00
Expended	379.83	
Transferred to Laborers and Gardeners	600.00	979.83
Balance		20.17

Expenses of Consulting Chemist

Appropriated		300.00
Expended		300.00

Horticultural Prizes

Appropriated		200.00
Expended	173.99	
Transferred to Circulars for Membership	15.00	188.99
Balance		11.01

Investigations at other Institutions

Appropriated		600.00
Expended		593.70
Balance		6.30

Insurance

Appropriated		450.00
Expended		380.60
Balance		69.40

Library

Appropriated		600.00
Expended		597.47
Balance		2.53

Laboratories

Appropriated			500.00
Expended	89.92		
Expended—Tropical Laboratory	295.15	385.07	
Transferred to Laborers and Gardeners		100.00	485.07
Balance			14.93

Lecturers and Lantern Slides

Appropriated		500.00
Transferred from Research Scholarships		75.00
		575.00
Expended		568.94
Balance		6.06

Museums and Herbarium

Appropriated		1,500.00
Transferred from Publications		500.00
		2,000.00
Expended	1,874.66	
Transferred to Contingent Fund	125.00	1,999.66
		34

Publications

Appropriated		3,500.00
Expended	2,499.12	
Transferred to Museums and Herbarium	500.00	
Transferred to Special Assistance	500.00	3,499.12
Balance		88

Photography

Appropriated		300.00
Expended		299.09
Balance		91

Research Scholarship

Appropriated		300.00
Expended	225.00	
Transferred to Lectures and Lantern slides	75.00	300.00

Salary of Secretary

Appropriated		1,500.00
Expended		1,500.00

Income of Lydig Fund (*Publications*)

Appropriated	1,000.00
Subscriptions to "North American Flora"	983.75
Sales of publications	1,148.34
Refunds	6.00
	3,138.09
Expended	3,799.97
Shortage	661.88

Income of Stokes Fund (Preservation of Native Plants)

Appropriated	100.00
Expended	—
Balance	100.00

Income of Students Research Fund (Aid for Students Research)

Appropriated	100.00
Expended	50.00
Balance	50.00

Income of Mills Fund

Appropriated		1,560.00
Expended—Purchase of Plants	157.11	
Expended—Exploration and Collecting	570.50	
Expended—Museums and Herbarium	270.97	
Expended—Lectures and Lantern Slides	247.55	
Expended—Library	297.53	
Total Expended		1,543.66
Balance		16.34
Total Appropriated for Garden Accounts		28,840.00
Subscriptions to "North American Flora."		983.75
Sales of Publications		1,148.34
Refunds		7.00
		30,979.09
Total Expended for Garden Accounts		31,301.89
Shortage		322.80

4. SPECIAL GARDEN ACCOUNTS

Plant Fund (*Conservatory Fund*)

Subscribed 1900	2,110.00
Subscribed 1901	25.00

Refund—Balance on draft	15.27	
Subscribed 1902	486.55	
Refund—Unexpended balance	9.70	
Subscribed 1903	200.00	
Sale of duplicate palms	100.00	
Sale of plants	78.00	
Sale of palms 1904	125.00	
Subscribed 1908	260.00	
Subscribed 1909	550.00	
Subscribed 1910	1,135.00	5,094.52
Expended 1900	710.44	
Expended 1901	1,437.42	
Expended 1902	404.41	
Expended 1903	447.66	
Expended 1904	121.21	
Expended 1908	245.65	
Expended 1909	133.28	
Expended 1910	1,500.74	5,000.81
Balance		93.71

Exploration Fund

Subscribed 1901	2,050.00
Refund—Balance on Draft	87.59
Subscribed 1902	2,130.00
Refund—Unexpended balance	180.56
Subscribed 1903	1,565.00
Refunds—Unexpended balances	275.11
Subscribed 1904	3,183.45
Refunds—Unexpended balances	110.50
Subscribed 1905	2,575.00
Sale of duplicate palms	100.00
Refund—part of expenses—Exploration to the Bahamas	125.00
Subscribed 1906	1,050.00
Subscribed 1907	2,510.00
Refunds	529.84
Subscribed 1908	3,930.00
Refund—Unexpended balance	14.49
Subscribed 1909	4,410.00
Refund—Unexpended balance	60.20

Subscribed 1910	4,100.00	
Refund—Unexpended balance	54.59	29,041.33
Expended 1901	2,130.95	
Expended 1902	1,258.32	
Expended 1903	2,880.72	
Expended 1904	2,878.28	
Expended 1905	3,003.37	
Expended 1906	1,027.25	
Expended 1907	2,274.84	
Expended 1908	3,912.13	
Expended 1909	5,091.22	
Expended 1910	4,579.70	29,026.78
Balance		4.55

Museum and Herbarium Fund

Subscribed 1901	1,800.00	
Subscribed 1902	655.00	
Refund (advance charges on specimens account of R. S. Williams)	131.09	
Subscribed 1903	1,405.00	
Sale of specimens	29.50	
Subscribed 1904	100.00	
Subscribed 1906	2,550.00	
Subscribed 1908	1,575.00	
Subscribed 1909	200.00	
Subscribed 1910	800.00	9,245.59
Expended 1901	1,546.19	
Expended 1902	1,024.96	
Expended 1903	1,437.63	
Expended 1904	100.00	
Expended 1906	2,224.57	
Expended 1907	250.00	
Expended 1908	1,646.80	
Expended 1909	177.11	
Expended 1910	822.61	9,229.87
Balance		15.72

Special Book Fund

Subscribed 1899	4,950.00	
Subscribed 190	1,825.00	

Subscribed, 1902	2,265.00	
Subscribed 1903	1,315.00	
Special contribution from Mr. Andrew Carnegie	1,997.88	
Sale of Books	59.60	
Refunds—Balance on drafts	20.93	
Subscribed 1904	1,540.00	
Sale of duplicate books	15.15	
Subscribed 1905	2,175.00	
Sale of duplicate books	25.50	
Subscribed 1906	310.00	
Subscribed 1907	100.00	
Subscribed 1908	3,130.00	
Subscribed 1909	1,850.00	
Subscribed 1910	1,465.00	23,044.06
Expended 1899	1,916.65	
Expended 1900	2,395.28	
Expended 1901	2,463.02	
Expended 1902	2,256.25	
Expended 1903	3,397.75	
Expended 1904	1,031.92	
Expended 1905	2,178.99	
Expended 1906	748.29	
Expended 1907	195.28	
Expended 1908	2,760.36	
Expended 1909	720.71	
Expended 1910	±2,758.90	22,823.40
Balance		±220.66
Total Expended from Funds of the Garden		40,963.84

Respectfully submitted,

WALTER S. GROESBECK,
Accountant.

E. & O. E.

NEW YORK, January 9, 1911.

REPORT OF THE CHAIRMAN OF THE SCIENTIFIC DIRECTORS FOR THE YEAR 1910

To the Board of Managers of the New York Botanical Garden.

(*Presented and ordered printed January* 9, 1911.)

Gentlemen: In submitting our report for the year 1910, the Scientific Directors request your attention to several lines of the Garden's work which we deem worthy of special consideration.

Probably the most important scientific work in which the Garden has engaged is what might be called the collective investigation of the North American flora. The fruit of this work will consist in the publication of our systematic work on the subject, of which fourteen parts have now appeared, and ultimately that of some analytical work which shall seek to explain the composition and origin of our flora in its relation to that of the world. It is, however, the work itself in which we are here especially interested. Ever since the foundation of the Garden, the ground work by which alone the necessary data for these studies could be secured has been energetically and persistently pursued. All important collections offered by outsiders have been secured and all contributions studied, besides which we have endeavored to determine the most important directions in which our own explorations could supplement the work already performed. Out of the limited means at our command, we have conducted the following explorations in territory outside of the United States proper.

To Nova Scotia and Newfoundland	1
To Mexico	7
To Honduras	2
To Costa Rica	1
To Panama	3
To Bermuda	1

To Cuba	8
To Porto Rico	8
To St. Christopher Island	1
To Hayti	2
To Santo Domingo	2
To Montserrat	2
To Jamaica	11
To the Bahamas	13
Total	62

In addition to these foreign expeditions, which it will be noted do not include our work in the Philippines, in Hawaii, and in South America, many have been conducted within the United States proper. Light on the same subject has been sought through a number of special investigations of our fossil flora and from a search of the floral records relating to contiguous territory.

To one not conversant with the extent of the requirements for the solution of problems relating to the geographic and evolutionary origin of a flora, this may seem like a mere amassing of museum and herbarium material, while to the critical student it means the correction or verification of important records, the tracing of the lines of plant distribution, extinction, and development, and even of contributions to the history of climatic and geographic changes. It is, indeed, natural history in its broadest sense. Above all, it should be remembered that such a problem cannot be solved until after all of its factors have been determined. Seven excursions into Cuba, ten into Jamaica, or twelve to the Bahamas, may fail to establish the one important condition which will be recorded by the eighth, eleventh, or thirteenth respectively. It is the opinion of our Director-in-Chief, whose important duty it has been to analyse and collate this enormous accummulation of facts, that the results of this extended work of exploration have been highly profitable and satisfactory, and that we are in a position to understand the nature of our flora as we could not possibly have done without this decade of laborious and patient investigation.

Since this is the most important scientific work in which we have engaged, and since its accomplishment would have been quite impossible by the aid of the fixed income of the Garden alone, the Directors take a special pleasure in acknowledging their indebtedness to the many donors who have annually contributed to our special fund for this purpose, and in expressing our appreciation of their intelligent generosity.

In view of the vast area and diversified climatic conditions of the Republic of Mexico, the amount of work that has been done in that country appears to be relatively much smaller than that in other parts of North America. This is perhaps especially true of both of its coastal regions, and of its series of high southern mountains, by which our own western mountain systems are linked to the South American Andes. It is greatly to be desired that some carefully selected exploration work should be performed in that country, in good time for the utilization of the results in the remaining monographs of NORTH AMERICAN FLORA.

In this connection, and because of the necessity of having the herbarium results of these explorations in form for quick and convenient examination, reference is here made to the extra effort of the past year to mount and place in the herbarium and museum the great number of specimens which will be mentioned in the report of our Curator. The result is that practically all of the hundreds of thousands of specimens owned by the Garden are now readily accessible, both to our own staff and to visiting students. It is hoped that during the coming year it will be found possible to complete the external indication of the contents of the shelves of the Garden's herbarium cases, thus saving much valuable time which is now lost in locating specimens which it is desired to consult.

Concurrently with this study of our general flora, some remarkably productive work, of a rather novel character, has been pursued in the investigation of our local flora.

relating to the natural laws governing its distribution. For this work our Mr. Taylor is to be credited, and we have reason to believe that facts of importance in relation to phytogeography will by it become established.

Although the direction of the Economic Museum is under the immediate care of the writer, he ventures to again bring to your attention certain important features of those collections, features in which our Economic Museum differs from all others of which we have knowledge. While the primary object of such a museum is to record and place on exhibition illustrations of the economic relations of the vegetable kingdom to man, it is possible to so conduct it that it will contribute in important ways to the solution of strictly scientific problems. It is the edible properties of plants, which, on the one hand, contribute in the most important ways to their distribution and, on the other, determine plant evolution. Since the edible portions of plants are for the most part of such bulk or consistence as to largely exclude them from the general herbarium, but specially fits them for representation in the Economic Museum, it follows that the student of general botany may here alone find much material that is actually indispensable in his studies. To impart such a character to our Economic Museum, and to render it thus valuable, has been our constant aim in its construction, and it is believed that none can seriously examine it without being impressed by the results. During the past year, the contributions have been specially characterized by these features, and it has actually happened that two species of plants, represented in no other collection, have been described from the specimens of edible fleshy fruits deposited here.

The work of elementary education in which we have engaged during 1910 has been exceptionally profitable. The continuation of our public lectures throughout the summer has been found quite as acceptable to the public as was anticipated and the results are considered as amply justifying the continuance of this plan.

With a collection of lantern slides which now numbers more than 7,000, with collections of living plants which, though not so complete as could be desired, yet offer a large amount of material for illustration, and with a staff whose experience has been greatly enriched by travel as well as by laboratory research, it would appear to be a serious waste of opportunity to permit our lecture room to remain unused whenever interested and appreciative audiences are forthcoming.

Our lectures to the school children of the Bronx have been given as usual, and the interest in them by teachers, as well as by pupils, has continued unabated. The noticeably and increasingly numerous visits of young people to our collections is probably largely due to their introduction to our Garden while yet school children by means of these lectures, which have now been continued for about four years.

In connection with our lecture work, and as an additional and important educational influence, we are at the present time greatly interested in the installation of a collection of large photographs, to be placed upon our walls, consisting of typical illustrations of the arborescent flora of the world. The nature of this work is discussed in the report of the Director-in-Chief.

Very acceptable also to the public has been the opportunity of being conducted over the grounds by a competent guide, through our provision of a Docent, who leaves the Museum at a stated hour, visiting certain portions of the Garden on stated days, and explaining the scientific, as well as the popular features of the various exhibits. We have been fortunate in having this important work inaugurated by one of such pleasing personality, and with such peculiarly good qualifications for it as Mr. Percy Wilson.

The experiment of providing reading labels on our museum specimens, giving explanatory facts in addition to bare details, has been found to work so satisfactorily that it will be greatly extended during 1911.

The research work performed under the direction of Mr. Seaver is too extended to admit of review here, and we must refer you to the report of the Director of the Laboratories.

In the report of the Librarian will be found an extended account of what is probably the most important single increase in our book collection that has ever been made.

Although we have repeatedly recognized, in these Reports, the Garden's need of increased endowment, yet, because this need is such a real and compelling one, we feel that it must again be brought to your attention. The rapid extension of our cultivated area, the greater number of plant houses, the establishment of new departments and new publications, the acquirement of new botanical literature, to say nothing of the accumulation of the older works, which become steadily more scarce and costly, the satisfaction of those public educational demands which have been largely developed by our own activity, the suitable compensation of scientific aids who have too long been left to an unequal struggle with increasing living expenses,—all these are but the natural, proper, and inevitable increases of responsibility which mark the progress of a successful institution such as this.

We cannot close this report, somewhat in the nature of a review of our seventeen years of life, without paying a tribute to the almost unvarying record of genuine scientific interest and faithful and unselfish service of our Staff. There has perhaps never been a more perfect instance of loving service to such an institution, service in which generous provision and faithful attention by the management have been recognized and requited by an equally faithful service in detail. Looking back over the progressive work accomplished, though under the unfavorable conditions accompanying a period of construction, in relation to the gross expenditure, the results appear disproportionate; it would appear as though every dollar must have done the work of two. Respectfully submitted,

H. H. Rusby,
Chairman.

REPORT OF THE COMMITTEE ON PATRONS, FELLOWS AND MEMBERS FOR THE YEAR 1910

To the Board of Managers of the New York Botanical Garden.

Gentlemen: The number of new members who have qualified during the past year is 54. The number of annual members is now 827; life members 159; sustaining members 22; fellowship members 5.

Of these, 40 are now in arrears for dues for 1910, 5 are in arrears for 1909 and 1910, 12 are in arrears for 1908, 1909 and 1910, 5 are in arrears for 1907, 1908, 1909 and 1910 and 4 are in arrears for 1906, 1907, 1908, 1909 and 1910.

Dues have been collected to the amount of $8,990, which has been transmitted to the Treasurer as received.

5 persons have qualified as life members by the payment of $250 each. These sums have been transmitted to the Treasurer for credit to the Endowment Fund.

A complete list of all classes of members to date is herewith submitted.

New York, January 9, 1911.

Benefactors

Hon. Addison Brown,
Andrew Carnegie
Columbia University,
* Hon. Charles P. Daly,
* D. O. Mills,
J. Pierpont Morgan
John D. Rockefeller,
* Cornelius Vanderbilt.

Patrons

Oakes Ames,
* Mrs. Geo. Whitfield Collord,
* James M. Constable,
* Wm. E. Dodge,
Geo. J. Gould,
Miss Helen M. Gould,
Mrs. Esther Herrman,
* John S. Kennedy,
* Oswald Ottendorfer,
Lowell M. Palmer,
William Rockefeller,
* Wm. R. Sands,
* Wm. C. Schermerhorn,
Jas. A. Scrymser,
* Samuel Sloan,
Mrs. Antoinette Eno Wood.

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* Deceased.

FELLOWS FOR LIFE

James B. Ford,
John Innes Kane,
Hon. Seth Low,
M. F. Plant,
Francis Lynde Stetson,
Miss Olivia E. Phelps Stokes,
Samuel Thorne,
Tiffany & Co.,
H. C. von Post.

LIFE MEMBERS

Edward D. Adams,
Dr. Felix Adler,
A. G. Agnew,
Mrs. James Herrman Aldrich,
Bernard G. Amend,
Constant A. Andrews,
J. Sherlock Andrews,
Dr. S. T Armstrong,
Mrs. H. D. Auchincloss,
Samuel P. Avery,
Samuel D. Babcock,
Geo. V. N. Baldwin,
Miss Cora F. Barnes,
Dr. John Hendley Barnhart,
Gustav Baumann,
Samuel R. Betts,
Miss Elizabeth Billings,
Miss Mary M. Billings,
Miss Catherine Bliss,
J. O. Bloss,
George Blumenthal,
George C. Boldt,
G. F. Bonner,
Geo. S. Bowdoin,
J. Hull Browning,
Joseph Bushnell,
T. Morris Carnegie,
Frank R. Chambers,
Hugh J. Chisholm,
Hugh J. Chisholm, Jr.,
Geo. C. Clark,
Banyer Clarkson,
Dr. James B. Clemens,
Wm. F. Cochran,
William Colgate,
Miss Georgette T. A. Collier,
Mrs. William Combe,
W. E. Connor,
Theodore Cooper,
Zenas Crane,
R. N. Cranford,
Melville C. Day,
Mrs. John Ross Delafield,
Miss Julia L. Delafield,
Maturin L. Delafield, Jr.,
Anthony Dey,
W. B. Dickerman,
James Douglas,
Miss Josephine W. Drexel,
Miss Ethel DuBois,
Miss Katharine DuBois,
Wm. A. DuBois,
Geo. E. Dunscombe,
Thomas Dwyer,
Newbold Edgar,
George Ehret,
David L. Einstein,
Ambrose K. Ely,
Amos F. Eno,
Edward J. Farrell,
Mrs. H. J. Fisher,
Andrew Fletcher,
Chas. R. Flint,
Henry C. Frick,

Mrs. Theodore Kane Gibbs,
James J. Goodwin,
Daniel Guggenheimer,
Bernard G. Gunther,
Franklin L. Gunther,
Frederic R. Halsey,
Chas. J. Harrah
Dr. Louis Haupt,
R. Somers Hayes,
James J. Higginson,
George B. Hopkins,
Samuel N. Hoyt.
Gen. Thos. H. Hubbard,
Archer M. Huntington,
Frank D. Hurtt,
James H. Hyde,
Mrs. Columbus O'D. Iselin,
Theo. F. Jackson,
Dr. Walter B. James,
Dr. E. G. Janeway,
Miss Annie B. Jennings,
Walter R. T. Jones,
Eugene Kelly, Jr.,
Nathaniel T. Kidder,
William M. Kingsland,
H. R. Kunhardt,
W. B. Kunhardt,
Charles Lanier,
W. V. Lawrence,
Meyer H. Lehman,
Mrs. Geo. Lewis,
Joseph Loth,
David Lydig,
C. W. McAlpin,
Guy R. McLane,
Emerson McMillin,
Wm. H. Macy, Jr.,
Mrs. Wm. H. Macy, Jr.,
Dr. Francis H. Markoe,
Louis Marshall,
Edgar L. Marston,
Bradley Martin,
William J. Matheson,
Dr. Geo. N. Miller,
A. G. Mills,
Hon. Levi P. Morton,
Sigmund Neustadt,
A. Lanfear Norrie,
Gordon Norrie,
Geo. M. Olcott,
Mrs. Chas. Tyler Olmstead,
Wm. Church Osborn,
Henry Parish,
Wm. Hall Penfold,
Geo. W. Perkins,
W. H. Perkins,
James Tolman Pyle,
M. Taylor Pyne,
Geo. W. Quintard,
J. C. Rodgers,
Thomas F. Ryan,
Dr. Reginald H. Sayre,
Edward C. Schaefer,
F. Aug. Schermerhorn,
Jacob H. Schiff,
Mortimer L. Schiff,
Grant B. Schley,
Mrs. I. Blair Scribner,
Isaac N. Seligman,
Geo. Sherman,
William D. Sloane,
James Speyer,
Anson Phelps Stokes,
Miss Ellen J. Stone,
Albert Tag,
Paul G. Thebaud,
Charles G. Thompson,
Mrs. Frederick F. Thompson,
Robert M. Thompson,
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John C. Eno,
R. Erbsloh,

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Louis Ettlinger,
Richard Evans,
A. W. Evarts,
H. C. Fahnestock,
Chas. V. Faile,
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Samuel W. Fairchild,
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H. Fernstrom,
Pliny Fisk,
Harry Harkness Flagler,
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Scott Foster,
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A. S. Frissell,
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R. W. Gibson,
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Chas. Gotthelf,
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Edwin Gould,
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Isaac J. Greenwood,
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W. C. Gulliver,
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W. S. Gurnee, Jr.,
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John A. Hadden, Jr.,
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Wm. Halls, Jr.
Miss Laura P. Halsted,
Miss Mary M. Halsted,
Wm. Hamann,
Miss Katherine L. Hamersley,
Louis Gordon Hamersley,
Miss Adelaide Hamilton,
Miss Elizabeth S. Hamilton,
Jas. B. Hammond,
Chas. T. Harbeck,
Mrs. Anson Wales Hard,
Anson W. Hard,
T. E. Hardenbergh,
J. Montgomery Hare,
E. S. Harkness,
S. W. Harriot,
N. W. Harris,
William Hamilton Harris.
Miss Rebecca Harvey,

Jacob Hasslacher,
J. C. Havemeyer,
T. A. Havemeyer,
J. Woodward Haven,
Matthew Hawe,
Miss Caroline C. Haynes,
Wm. W. Heaton,
Julius Heimann,
Arthur P. Heinze,
Homer Heminway,
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Francis Hendricks,
Harmon W. Hendricks,
Gus. C. Hennings,
Ferdinand Hermann,
Selmar Hess,
H. H. Hewitt,
Mrs. Sarah A. Hewitt,
Walter Hinchman,
Chas. S. Hirsch,
J. Oakley Hobby,
B. Hochschild,
Alfred G. Hoe,
Richard M. Hoe,
Mrs. Richard March Hoe,
Mrs. Robert Hoe,
Bernhard Hoffman,
John Swift Holbrook,
E. R. Holden,
Henry Holt,
Frederick B. House,
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M. D. Howell,
Alfred W. Hoyt,
John Sherman Hoyt,
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Karl Hutter,
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John B. Ireland,
Adrien Iselin, Jr.,
C. Oliver Iselin,
Miss Georgine Iselin,
William E. Iselin,
Samuel Isham,
Wm. M. Ivins,
Dr. Abram Jacobi,
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Dr. Robert C. James,
E. C. Jameson,
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Walter Jennings,
Mrs. Maria de W. Jesup,
Adrian H. Joline,
Dwight A. Jones,
Mrs. Townsend Jones,
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Louis Kahn,
Miss Louise Landgon Kane,
Mrs. H. F. Kean,
Frank Browne Keech,
Mrs. Chas. Kellogg,
Thos. H. Kelly,
Prof. J. F. Kemp,
H. Van Ransselaer Kennedy,
David Keppel,
Rudolph Keppler,
Mrs. Catherine L. Kernochan,
John B. Kerr,
Geo. A. Kessler,
Patrick Kiernan,
S. E. Kilner,
Alfred R. Kimball,
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M. K. King,
Gustave E. Kissel,
E. C. Klipstein,
Hermann Knapp,
Roland F. Knoedler,
Chas. Kohlman,
H. C. Kudlick,
Adolf Kuttroff,
Francis G. Landon,
Edward V. Z. Lane,
Woodbury Langdon,
Woodbury G. Langdon,
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Dr. G. Langmann,
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Mrs. Lydia G. Lawrence,
Mrs. Samuel Lawrence,
Charles N. Lee,
Prof. Frederic S. Lee,
Mrs. Frederic S. Lee,
Marshall C. Lefferts,
Wm. H. Lefferts,
James M. Lehmaier,
Edward A. Le Roy, Jr.,
Arthur L. Lesher,
Dr. A. Monae Lesser,
Wm. H. Leupp,
Enamuel Levy,
Mrs. John V. B. Lewis,
Adolph Lewisohn,
Albert Lewisohn,
Miss Alice Lewisohn,
Philip Lewisohn,
Lowell Lincoln,
Frederick J. Lisman,
Wm. S. Livingston,
Wm. C. Lobenstine,
James Loeb,
Mrs. Geo. de Forest Lord,
P. Lorillard, Jr.,
R. P. Lounsberry,
Miss Carlotta R. Lowell,
August Lueder,
Walther Luttgen,
Geo. L. McAlpin,
John J. McCook,
Mrs. W. H. McCord,
John A. McKim,
James McLean,
Geo. R. MacDougall,
Clarence H. Mackay,
Kenneth K. Mackenzie,
Malcolm MacMartin,
George H. Macy,
V. Everit Macy,
F. Robert Mager,
J. H. Maghee,
Pierre Mali,
Chas. Mallory,
Chas. E. Manierre,
Howard Mansfield,
Miss Delia W. Marble,
John Markle,
Dr. J. W. Markoe,
C. P. Marsh,
Chas. H. Marshall,
Edwin S. Marston,
W. R. H. Martin,
George Massey,
William J. Matheson,
Francis Taylor Maxwell,
Robert Maxwell,
David Mayer,
Harry Mayer,
Effingham Maynard,
D. J. Medbury,
Mrs. Emma Mehler,
Herman A. Metz,

Edwin O. Meyer,
George A. Meyer,
Harry J. Meyer,
Geo. M. Miller,
S. M. Milliken,
Alphonse Montant,
Chas. Arthur Moore, Jr.,
J. C. Moore,
Miss Anne T. Morgan,
Miss C. L. Morgan,
E. D. Morgan,
Geo. H. Morgan,
Wm. Fellows Morgan,
A. Newbold Morris,
Mrs. A. Newbold Morris,
Mrs. Cora Morris,
Mrs. Dave Hennen Morris,
Henry Lewis Morris,
Louis R. Morris,
Geo. Austin Morrison,
Richard Mortimer,
Henry C. Mott,
Frank J. Muhlfeld,
Carl Muller,
John P. Munn,
Frank A. Munsey,
A. G. Nesbit,
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Miss Edith Newbold,
Frederic R. Newbold,
H. Victor Newcomb,
Wm. Nilsson,
Adolph S. Ochs,
Robert C. Ogden,
E. E. Olcott,
Robert Olyphant,
Mrs. Emerson Opdycke,
Wm. S. Opdyke,
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William C. Orr,
Prof. Henry F. Osborne,
Augustus G. Paine,
S. S. Palmer,
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Winthrop Parker,
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Phillips Phoenix,
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Michael Piel,
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Ralph Pulitzer,
J. Harsen Purdy,
L. Putzel,

Percy R. Pyne,
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Charles Raht,
Gustav Ramsperger,
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Wm. A. Read,
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Henry S. Redmond,
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E. B. Reynolds,
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Wm. J. Riker,
H. Dillon Ripley,
George L. Rives,
Dr. Wm. C. Rives,
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Miss Mary M. Roberts,
Miss Jennette Robertson,
Julius Robertson,
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Henry J. Robinson,
M. Rock,
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Mrs. W. Emlen Roosevelt,
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Paul J. Sachs,
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Gustave Schirmer,
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Benson B. Sloan,
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Daniel Smiley,
Chas. F. Smillie,
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Mrs. James Sullivan,
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Miss Mary Taber,
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James Talcott,
C. A. Tatum,
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Henry R. Taylor,
Stevenson Taylor,
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C. H. Tenney,
H. L. Terrell,
Jno. T. Terry,
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Ernst Thalmann,
Benjamin Thaw,
Miss M. J. Thayer,
Seth E. Thomas,
David W. Thompson,
L. S. Thompson,
Dr. W. Gilman Thompson,
Jonathan Thorne,
Samuel Thorne, Jr.,
W. V. S. Thorne,
Myles Tierney,
Louis C. Tiffany,
Frank Tilford,
James Timpson,
J. Kennedy Tod,
William Tousey,
Miss Amy Townsend,
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Paul Tuckerman,
Geo. E. Turnure,
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E. S. Twining,
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E. S. Ullman,
Mrs. Lawsen Valentine,
Augustus Van Cortlandt,
Alfred G. Vanderbilt,
Frank Vincent,
D. B. Van Emburgh,
E. H. Van Ingen,
Edgar B. Van Winkle,
Robert A. Van Wyck,
Thos. F. Vietor,
Frank Vincent,
Richard C. Veit,
Herman Vogel,
John Wagner,
Wm. I. Walter,
Artemus Ward,
Wm. T. Wardwell,
E. H. Weatherbee,
Mrs. John A. Weekes,
Chas. Wehrhane,
Camille Weidenfeld,
Mrs. Samuel W. Weiss,
Charles W. Wells,
Mrs. John Wells,
Mrs. Robert E. Westcott,
Geo. Westinghouse,
Mrs. Alice T. Wheelock,
Dr. Wm. E. Wheelock,
Miss Caroline White,
Horace White,
John J. White, Jr.,
Miss Gertrude Whiting,
Giles Whiting,
Clarence Whitman,
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Wm. Wicke,
Edward A. Wickes,
D. O. Wickham,
Blair S. Williams,
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Richard H. Williams,
W. P. Willis,
Charles T. Wills,
George T. Wilson,
Henry R. Wilson,
Mrs. H. S. Wilson,
Miss Margaret B. Wilson,
Egerton Winthrop,
Grenville L. Winthrop,
Mrs. Robt. Winthrop,
Mrs. Frank S. Witherbee,
Dr. R. A. Witthaus,
Ernst G. W. Woerz,
Emil Wolff,
Lewis S. Wolff,
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Henry R. Wood,
James Wood,
Prof. R. S. Woodward,
W. H. Woolverton,
P. B. Worrall,
Miss Julia Wray,
Mrs. J. Hood Wright,
A. Wurzburger,
Jno. J. Wysong,
Edw. L. Young,
Andrew C. Zabriskie,
Mrs. John E. Zimmermann,
August Zinsser,
Charles Zoller,
O. F. Zollikoffer.

REPORT OF THE TREASURER

New York, January 6, 1911.

To the Board of Managers of the New York Botanical Garden.

Gentlemen: Herewith I submit a statement of my Receipts and Disbursements during the year 1910, and a Balance Sheet from my ledger as of December 31, 1910.

Respectfully yours,
C. F. Cox,
Treasurer.

Receipts

Balance as per last Annual Report..............		$ 22,694.18
Contributions of the City towards Development and Maintenance.................		85,934.53
Income from Investments:		
Credited General Income Account:		
5 per cent. on $50,000 Southern Railway Co. First Consolidated Mtge. Bonds..................	$ 2,500.00	
4.5 per cent. on $50,000 Ches. & Ohio R. R. Co. General Mtge. Bonds................	2,250.00	
4 per cent. on $50,000 Erie R. R. Co. Prior Lien Bonds.	2,000.00	
4 per cent. on $59,000 Erie R. R. Co. Penn. Collat. Trust Bonds.......	2,360.00	
4 per cent. on $50,000 Reading R. R. Co. Jersey Central Collat. Trust Bonds............	2,000.00	
4 per cent .on $24,000 Northern Pacific R. R. Co. St. Paul & Duluth Division Bonds..........	960.00	
4 per cent. on $30,000 Northern Pacific Co. Gt. Northern, C. B. & Q. Collat. Trust Bonds..	1,200.00	

4 per cent. on $10,000 N. Y. City 4 per cent. Stock of 1959 (interest from Dec. 10, 1909, to Nov. 1, 1910)	356.70	13,626.70
Credited Income of D. O. Mills Fund:		
3 per cent. on $49,000 Can. So. First Mtge. Extended Bonds July 1, 1910	1,470.00	
3 per cent. on $50,000 Can. So. First Mtge. Extended Bonds Dec. 31, 1910	1,500.00	2,970.00
Legacy of D. O. Mills, credited Darius Ogden Mills Fund		50,000.00
Annual Dues		7,880.00
Interest at 3 per cent. on balances with J. P. Morgan & Co.		709.02
Proceeds Sales of Merchandise		98.00
Endowment Fund—contribution		100.00
Life Membership Fees		1,250.00
Fellowship Members' Fees		500.00
Sustaining Members' Fees		625.00
Tuition Fees credited "Students' Research Fund"		115.00
Subscriptions to "North American Flora" and sales of Publications credited Income of David Lydig Fund		2,105.38
Contributions to Special Book Fund		1,465.00
Contributions to Plant Fund		1,135.00
Contributions to Exploration Fund		4,214.79
Contributions to Museum and Herbarium Fund		800.00
		196,222.60

Disbursements

Expenses paid through Director-in-Chief:	
Account city appropriations	85,934.53
On General Account for Vouchers paid	25,971.98
Special Book fund for books	2,632.23
Plant Fund for purchase of plants	1,294.43
Exploration Fund for specimens, etc.	4,674.37

Museum and Herbarium Fund for purchases, etc.	822.61	
Income of Students' Research Fund for Grant	50.00	
Income of David Lydig Fund for Publications	3,229.96	
Income of D. O. Mills Fund for Exploration	445.50	
Invested in Purchase of $10,000 New York City 4 per cent. Stock of 1959 at 99¼, commission and interest	9,988.61	
Invested in Purchase of $50,000 Canada Southern Ry. Co. First Mtge. extended 6 per cent. Bonds at 104 and 104½, commission and interest	53,552.98	188,597.20
Balance, Cash in hands of Treasurer		$ 7,625.40

LEDGER BALANCES, DECEMBER 31, 1910.

Credit

Permanent Funds

Endowment Fund	$281,260.00	
Darius Ogden Mills Fund	50,000.00	
Fellowship Fees,	11,000.00	
Life Membership Fees	20,750.00	
David Lydig Fund—Bequest of Chas. P. Daly	34,149.86	
Stokes Fund	3,000.00	
Students' Research Fund	2,984.50	
		[illegible]

Temporary Funds

Special Book Fund, for Library	686.08
Plant Fund, for Plants	300.02
Exploration Fund	54.55
Museum and Herbarium Fund	15.72
Income of Students' Research Fund	423.78
Income of Stokes Fund	419.13
Income of D.O. Mills Fund:	
Int. allowed by J. P. Mor-	

gan & Co. on cash before investment...........		478.62		
Can. So. coupons collected		2,970.00		
		3,448.62		
Less commissions and accrued int. paid on bonds, charged off July 1.....	1,445.48			
Proportion of premium paid on bonds, charged off Dec. 31....	500.00			
Vouchers paid, for Exploration	445.50	2,390.98	1,057.64	$406,101.28

Debit

Investments

Net Cost of $50,000 Ches. & Ohio Ry. Co. Genl. Mtge. Bonds.	$364,156.68
$50,000 Southern Ry. Co. 1st Consol. Mtge. Bonds........	
$50,000 Erie R. R. Co. Prior Lien Bonds................	
$59,000 Erie R. R. Co. Penn. Coll. Trust Bonds	
$50,000 Reading R. R. Co. Jersey Cent. Coll. Trust Bonds ..	
$24,000 Nor. Pac. R. R. Co. St. Paul & Duluth Div. Bonds..	
$30,000 Nor. Pac. Gt. Nor. C. B. & Q. Coll. Trust Bonds......	
$10,000 N. Y. City 4 per cent. Stock, 1959.	
$50,000 Can. So. Ry. Co. First Mtge. Ext. Bonds	
Director-in-Chief, Working Fund....	25,000.00
General Income Account, Balance borrowed from Permanent Funds .	7,528.00

Income of David Lydig Fund, Balance borrowed from Permanent Funds	1,791.20	
Cash in hands of Treasurer	7,625.40	
	$406,101.28	$406,101.28

REPORT OF THE SPECIAL AUDITOR

TREASURER'S ACCOUNT FOR THE YEAR 1910

66 BROADWAY,
NEW YORK, February 9, 1911.

JAMES A. SCRYMSER, ESQUIRE,
Chairman of the Finance Committee,
New York Botanical Garden,
New York City.

Sir: This is to certify that I have, by your direction, examined the books and accounts of the Treasurer of the New York Botanical Garden for the year nineteen hundred and ten (1910), together with their proper vouchers, and I find the Balance Sheet and the Treasurer's Statement of Receipts and Disbursements, attached hereto, to be correct.

I have also examined the various Investment Securities, and find the same to be as reported in the said Balance Sheet.

Respectfully submitted,
(signed) J. L. MERRILL,
Special Auditor.

DIRECTOR-IN-CHIEF'S ACCOUNT FOR THE YEAR 1910.

66 BROADWAY,
NEW YORK, FEBRUARY 9, 1911.

JAMES A. SCRYMSER, ESQUIRE,
Chairman of the Finance Committee,
New York Botanical Garden,
New York City.

Sir: This is to certify that I have, by your direction, examined and audited the financial books and accounts of the Director-in-Chief of the New York Botanical Garden for the year nineteen hundred and ten (1910), and that I find the same to be correct and the Cash Balance to be as stated in the Current Cash Book.

This auditing does not include the examination of the vouchers for either City Maintenance or Construction Work, paid for by the City, such vouchers having been found proper and in order by the City authorities and you having decided in 1904 that a further examination of them by me was unnecessary.

I have omitted, also, a detailed examination of the Annual Membership Dues Account, as per like instructions in 1904. These dues are received by the Director-in-Chief and forwarded by him to the Treasurer, the former keeping a detailed record of the same.

Respectfully submitted,
(signed) J. L. MERRILL,
Special Auditor.

VOL. 7 NO. 26

BULLETIN
OF
THE NEW YORK BOTANICAL GARDEN

1891

[ISSUED OCTOBER 12, 1911]

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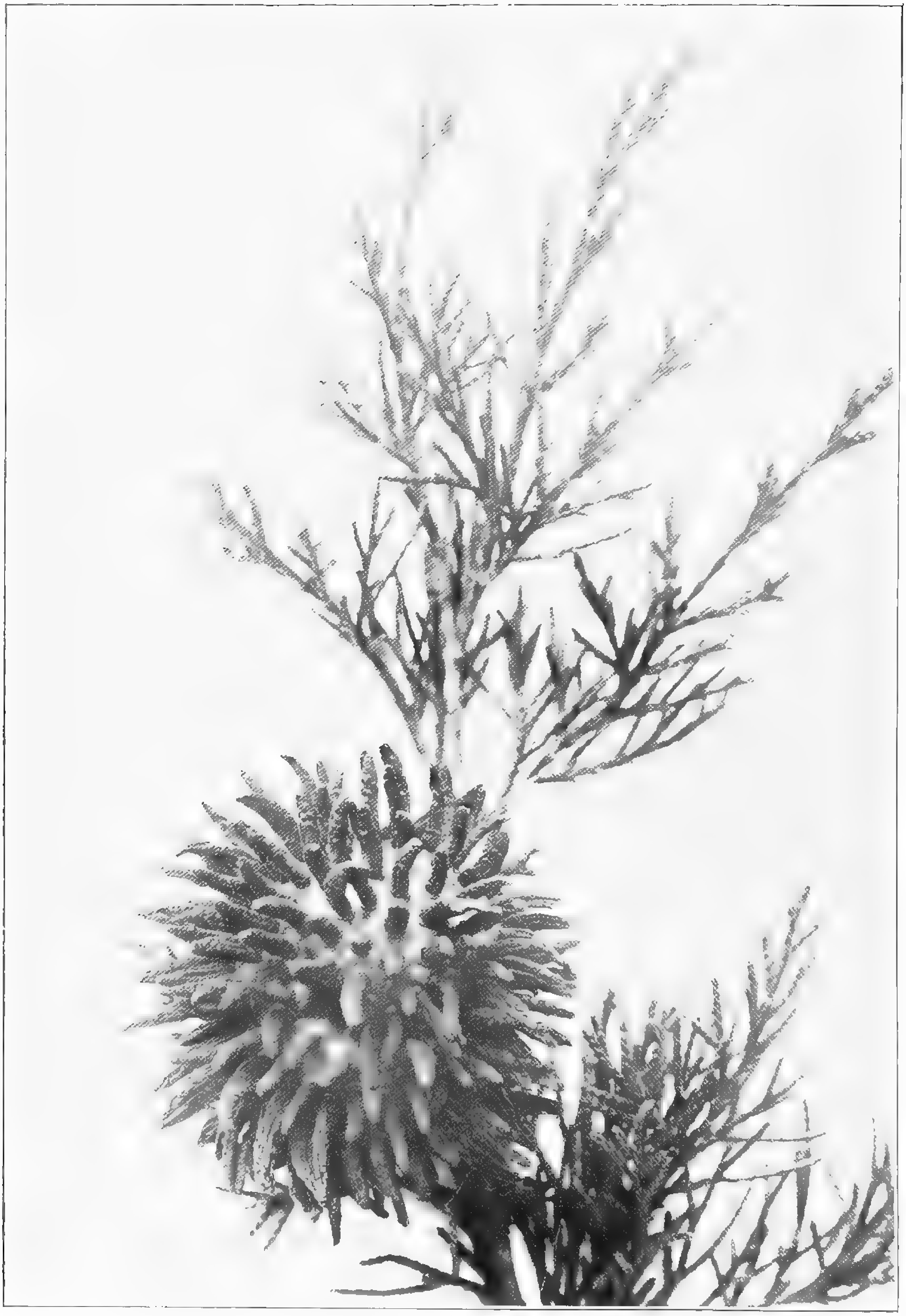

GYMNOSPORANGIUM JUNIPERI-VIRGINIANAE

THE COMMON "CEDAR-APPLE"

BULLETIN

OF

The New York Botanical Garden

Vol. 7. No. 26.

A Biologic and Taxonomic Study of the Genus Gymnosporangium

BY FRANK DUNN KERN

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PREFATORY NOTE

The investigations, the results of which are set forth in this paper, were begun in 1906 at Purdue University and have been continued at the New York Botanical Garden, and at Columbia University. To the officers and botanical staffs of these institutions the author would express his appreciation of the valuable aid rendered. The writer has also enjoyed the freest access to the private herbarium and library of Professor J. C. Arthur, of Purdue University, and is under obligation to him for many valuable suggestions and much kindly assistance.

In addition to the field studies made in the vicinities where the work has been carried on, several important collecting and observational expeditions have been made to the Rocky Mountains, one to the southeastern Atlantic states, one to the Mammoth Cave region of Kentucky, and numerous ones to various localities in Illinois, Wisconsin, and Michigan.

The experimental studies of life-histories have been carried on in the greenhouses of the Purdue University Agricultural Experiment Station, during the growing seasons from 1906–1910 inclusive. These experiments form a part of an extended investigation of rusts conducted by the Station and the results have been published in the annual reports of Cultures of Uredineae (Arthur, 1907, '08[1], '09, '10[1]), but are briefly reviewed here in order to bring together the scattered information relating to *Gymnosporangium*.

In addition to the herbaria of the institutions mentioned above, the writer has had access to the material in the Cryptogamic Herbarium of Harvard University, Mycological Collection of the U. S. Department of Agriculture, and the Arnold Arboretum. The following institutions have loaned for examination either a part or all of their specimens of the genus *Gymnosporangium:* Iowa State College, Cornell University, Connecticut Agricultural Experiment Station, Alabama Polytechnic Institute, West Virginia Experiment Station, Delaware College and Experiment

Station, Missouri Botanical Garden, and the University of Vermont. To the curators of these herbaria thanks are due and are hereby most heartily accorded for the privilege of examining the collections under their charge.

For collections of materials representing different localities and for various assistance, acknowledgments are due to Mr. E. Bartholomew, Stockton, Kans.; Rev. J. M. Bates, Red Cloud, Neb.; Professor E. Bethel, Denver, Colo.; Dr. J. J. Davis, Racine, Wis.; Professor W. G. Farlow, Cambridge, Mass.; Dr. Ed. Fischer, Bern, Switzerland; Professor F. D. Heald, Austin, Texas; Dr. G. G. Hedgcock, Dr. Perley Spaulding, and Mr. Carl Hartley, Washington, D. C.; Professor E. W. D. Holway, Minneapolis, Minn.; Professor H. S. Jackson, Corvallis, Oregon; Professors M. E. Jones and A. O. Garrett, Salt Lake City, Utah; Professor F. E. Lloyd, Auburn, Ala.; Dr. Donald Reddick, Ithaca, N. Y.; Mr. A. B. Seymour, Cambridge, Mass.; Dr. A. R. Sweetser, Eugene, Oregon; Dr. H. Sydow, Berlin, Germany; Dr. W. Tranzschel, St. Petersburg, Russia; Dr. Roland Thaxter, Cambridge, Mass.; Professor S. M. Tracy, Biloxi, Miss.; and to generous friends in various parts of the country who have severally contributed specimens. I am also indebted to Mr. W. W. Eggleston of the U. S. Department of Agriculture, and to Mr. J. G. Jack of the Arnold Arboretum, for the determination of certain host plants.

The writer was first induced to begin a study of this group chiefly because of the great need of systematic work which is at once apparent to any one who attempts to determine specimens either of the cedar or apple rusts. Much work has been done with the group, and this fact, doubtless, has led many to suppose that it was well worked and that most of the problems concerning it were settled. In taking up the study of the group, the writer, however, experienced much difficulty both because the data left by the past workers were chaotic and especially because they were incomplete. An incentive for the continuation of these studies has been the possibility that a detailed study of such a parasitic group, with its restricted hosts and abbreviated life-cycles, might throw light on some of the broader biologic problems such as the nature of relationships between hosts and parasites, and the possible origin and present trend of development among pleomorphic and heteroecious forms.

The geographic range which these studies have covered has been gradually extended until it is now possible to present a treatment of all the species that have been described from any part of the world up to the present time, so far as they are known to the writer.

PART I

BIOLOGY OF THE GENUS GYMNOSPORANGIUM

1. Introduction

Life-History

The genus *Gymnosporangium* is composed of a group of species of strictly parasitic fungi having pleomorphic spore-forms. It is a member of the order Uredinales Diet. and is one of the several genera in that order in which an alternation of phases and heteroecism is conspicuously shown. The mycelium of one phase produces two spore-forms, pycnia (spermogonia) and aecia (aecidia), and inhabits, with three known exceptions, dicotyledonous angiosperms of the order Rosales, family Malaceae (Pomaceae). The mycelium of the other phase produces only one spore-form; telia (teleutosori) and inhabits, without any known exceptions, gymnosperms of the order Pinales, family Juniperaceae (Cupressineae). *Gymnosporangium* differs from all the other rust-genera which are heteroecious, except *Calyptospora*, by the lack of a repeating spore-form,* uredinial-stage (uredo-stage), in its life-cycle. It is a general rule that all species of the order Uredinales which are heteroecious possess four spore-forms, pycnia and aecia on one set of hosts and uredinia and telia on the other set, and it is a notable fact that only in the genera *Gymnosporangium* and *Calyptospora* are found species which are heteroecious and yet have one of these spore-forms omitted. In these two genera urediniospores are lacking in all of the present known species.

General Characters

Gymnosporangium as a genus is characterized, with a few exceptions, by a dingy-white, membranous peridium (called also pseudoperidium), which elongates into a tubular form and tends to rupture along the sides; by large, loosely joined, peridial cells usually conspicuously sculptured on the inner and side walls; by aeciospores having colored, mostly brownish, walls, usually with evident germ-pores; and by teliospores having hyaline pedicels, usually of great length, the outer portions of which swell in moisture and become gelatinized to form a jelly-like matrix in which the spores appear imbedded. Of further interest in connection with the telial stage are the characteristic swellings and galls which are produced by many of the species.

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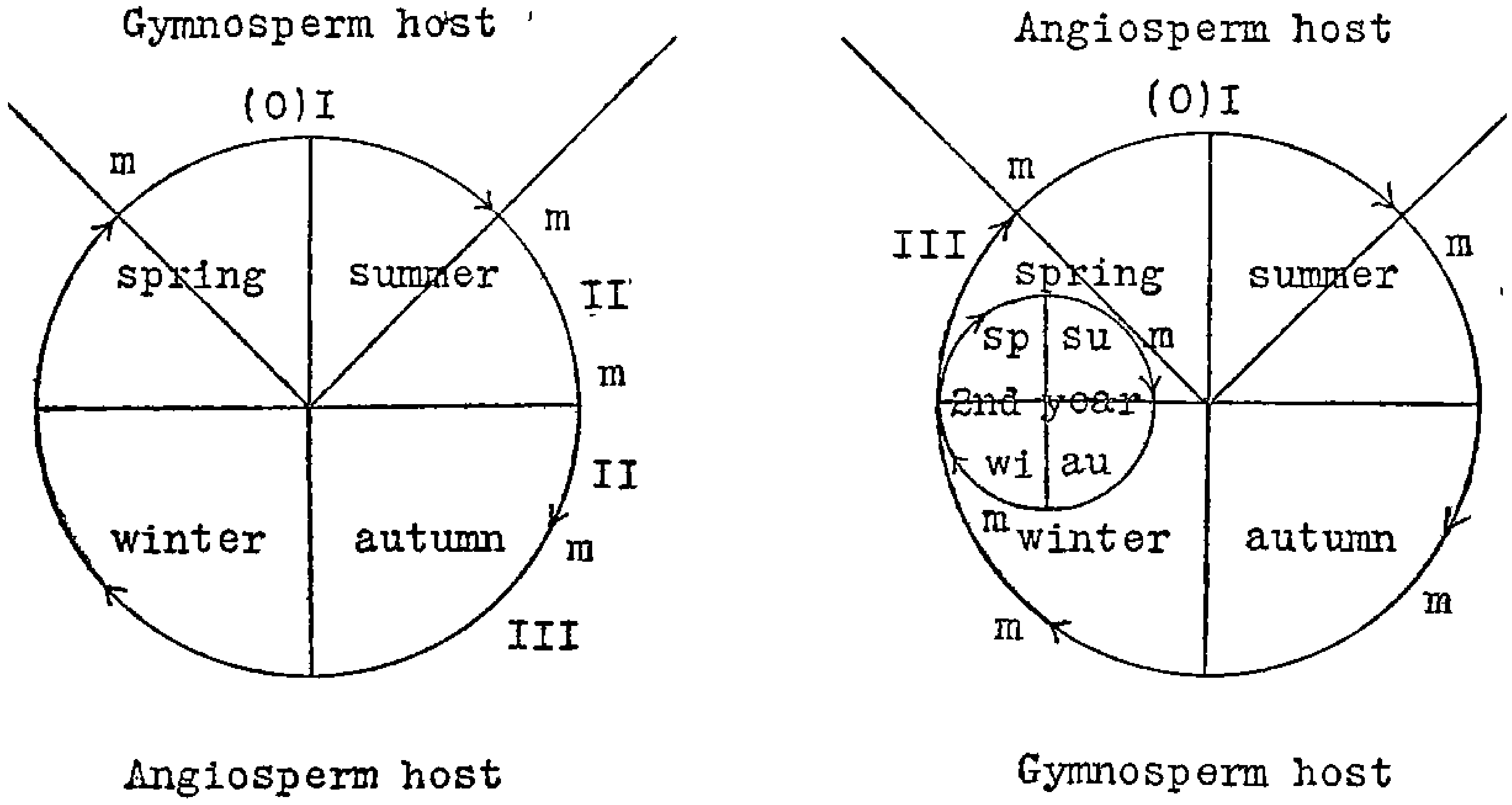
* A *repeating spore-form* is one which may reproduce the same stage over and over indefinitely.

COMPARISON WITH OTHER RUST-GENERA

Several other uredineal genera, *Coleosporium*, *Melampsoropsis*, *Pucciniastrum*, *Melampsorella*, *Melampsoridium*, and *Cronartium*, are known to have their antithetic phases inhabiting dicotyledonous angiosperms and coniferous gymnosperms and in all these the angiosperms bear the telia and the gymnosperms the aecia, but the order in *Gymnosporangium* is just the reverse. It is the only genus having this reverse order and as might be expected the reversal in the sequence of hosts is accompanied by a new departure in the physiological functions of the spores. In the genera mentioned above, *Coleosporium*, *Melampsoropsis*, etc., the teliospores,



a (Coleosporium,etc.) **b** (Gymnosporangium)

FIG. 1.—DIAGRAMS TO ILLUSTRATE THE LIFE-HISTORY OF RUSTS: **a**, the genera Coleosporium, Melampsoropsis, etc.; **b**, the genus Gymnosporangium. The symbols *O*, I, II, III, denote pycnia, aecia, uredinia, and telia respectively; *m*, mycelium. The repetition of any of the symbols indicates the repetition of that stage. The smaller circle in **b** is to indicate that the mycelium may continue on the gymnosperm host a second year before producing teliospores.

on the angiosperms function as resting spores, serving to carry the fungus through the winter, germinate in the spring and produce the aecial phase on the gymnosperms, where it remains until summer when it passes back to the angiosperm host again. In *Gymnosporangium* the teliospores are on the gymnosperms. They are active spores germinating upon maturity, producing the alternate phase on the angiosperm host, where it remains about the same length of time that the aecial phase of the other genera remained on the gymnosperm host, *i. e.*, about one quarter of the year, passing back in the late summer to the gymnosperm host. Here mycelium is produced which functions as a resting stage during the winter or possibly during two winters in some species. The foregoing diagrams may serve to illustrate these points.

Nuclear History

Although the nuclear phenomena in the rusts have been receiving considerable attention from cytologists in recent years, not a great deal of work has been done with the members of this group. Sappin-Trouffy (1896) and Blackman (1904) have used some of the species, especially *G. clavariaeforme*, in tracing certain of the nuclear changes. While our knowledge is still incomplete, it may, nevertheless, be well to briefly call attention to a few of the more essential points which have been demonstrated.

The basidiospores (sporidia) are uninucleated and give rise to a uninucleated mycelium which bears pycniospores, also uninucleated. At the base of the aecia, which soon begin to be formed from the same uninucleated mycelium which produced the pycnia, conjugation or cell-fusion takes place. This results in a binucleate condition of the aeciospores, owing to the fact that the nuclei from the two conjugating cells do not fuse. These nuclei divide conjugately in the mycelium originating from the aeciospores and remain separate until the teliospores are produced, where fusion is usually effected by the time the teliospores are mature.

It is to be noted that the method of conjugation in the type of aecium possessed by the species of *Gymnosporangium* has not yet been made clear. The work of Richards (1896), Olive (1908), and others indicates that in an aecium of this type the "fusion cell" does not at once function as a basal cell at the bottom of each spore-column, as it does in some types of aecia, but that large multinucleated cells first develop after conjugation and that the spore-columns originate as branches from these large multinucleated cells.

It has been suggested by a number of investigators that this nuclear history represents an alternation of generations. According to this view the gametophytic generation is uninucleated, has the reduced number of chromosomes, and beginning with the basidiospores gives rise to the pycnia with their pycniospores. The sporophyte is binucleated, has the double number of chromosomes, and beginning with the aeciospores gives rise to the telia with their teliospores (also to uredinia with their urediniospores when they appear). The gametophytic number of chromosomes is restored by a reduction division when the teliospore forms the four basidia in germination.

2. Distribution and Relationships

Problems

It is at once evident that the same environmental factors which affect the distribution of the higher plants cannot have the same influence, at least they cannot operate in the same way, on the distribution of parasitic plants. It is also so apparent, as to scarcely require mention, that the geographic distribution of the obligate parasite is limited by the distribution of hosts and cannot be found outside of their range. But as to whether the distribution of the parasite is coextensive with the range of the hosts, as it might be provided there were no other operating factors than the mere presence or absence of the hosts, is quite another question. In order to throw some light on this problem and to discover, if possible, the existence and nature of other factors, the distribution of the species of *Gymnosporangium* has been worked over. In this genus, where all but one of the known species are heteroecious, there is a possibility of gaining some idea (1) of the dependence of the fungus upon its two sets of hosts, (2) of the relation of the distribution of these sets of hosts to each other, and (3) of the comparison between that relationship and the distribution of the fungus. This opportunity is one peculiar to this genus because of its lack of repeating spores, *i. e.*, spores which are able to grow again on the same host and reproduce the phase from which they were derived, and of the consequent absolute necessity for the association of the two sets of hosts as a condition in the distribution of the fungus.

GENERAL DISCUSSION OF THE DATA OF DISTRIBUTION

In order to make some of the facts to be discussed more available for reference than they are in the systematic monograph of Part II some of the data of distribution have been arranged in tabular form (tables I, II and III).

TABLE I.—DISTRIBUTION OF THE SPECIES OF GYMNOSPORANGIUM ACCORDING TO THE TELIAL HOSTS AND THE CONTINENTS

Telial Hosts			Total No. of Species	North America	Europe	Asia	Africa (Algiers)
Order	Family	Genus					
Pinales (Coniferales)	Juniperaceae	Juniperus § Sabina	21	18	3	1 (Central)	–
		Juniperus § Oxycedrus	7	5	5	–	1
		Chamaecyparis	4	3	–	1 (Japan)	–
		Heyderia	1	1	–	–	–
		Cupressus	1	–	–	1 (India)	–

Upon examination of table I, attention is perhaps first drawn to the fact that the genus *Gymnosporangium* is known only in North America, Europe, Asia, and northern Africa. This is a case of host-limited distribution, the members of the family Juniperaceae being found only in the temperate zone of the northern hemisphere, extending in some places to the verge of the tropics. Also, most of the members of the family Malaceae, at least those that serve as hosts for *Gymnosporangium*, inhabit only the northern hemisphere.

Certain additional facts must be presented in connection with table I in order to bring out the essential features of the distribution of the species inhabiting the genus *Juniperus*. There is only 1 species which is known to inhabit both sections of the genus, that being *G. germinale*, a North American species. Of the 20 species inhabiting only § *Sabina*, 17 occur exclusively in North America, the remaining 3 in Europe, while 1 of the European species is also in central Asia. With the species inhabiting § *Oxycedrus*, the situation is quite different. Of the 6 species occurring exclusively on this section, 1 is distributed in North America, Europe, and northern Africa, 2 more are common to both North America and Europe, 2 are known only in Europe, and 1 only in North America.

It is worthy of note that the species inhabiting § *Sabina* are divided between the eastern and western continents, while of those inhabiting § *Oxycedrus*, at least 3 are distributed in both eastern and western hemispheres. In seeking to discover what might account for such a distribution one can scarcely avoid the suggestion that the phylogeny and distribution of the hosts may have been an important factor. It seems to be generally accepted that § *Oxycedrus*, with its subulate leaves, is of earlier origin than § *Sabina*, with its leaves awl-shaped when young and scale-like when mature. The same species of § *Oxycedrus*, *J. communis* and *J. sibirica*, are widely distributed over the cooler temperate regions of all the continents of the northern hemisphere. Such a wide distribution must have occurred during a geological period when the land conditions permitted migrations between the northern continents. If the species of *Gymnosporangium* were parasitic on these forms at this early time we would expect them to be widely distributed along with their hosts. Although no fossil species of *Gymnosporangium* are known, the existence of other fossil fungi makes the assumption of the existence of *Gymnosporangium* at this age not improbable. If § *Sabina* has developed from § *Oxydecedrus* and has done so since the continents have been isolated, we would not then expect to find the same species, either of hosts or fungi, indigenous in North America and in the Old World; and this, indeed, is the case so far as the writer has been able to learn.

As to why there should appear to be so many more species occurring on § *Sabina* in North America (18) than in Europe (3) a few suggestions may be offered. In the first place it may be said that the field and culture work of the writer has all been done in North America and that owing to this work the number of species known here has been somewhat extended in recent years, while similar studies have not been carried on to the same extent in Europe. The ratio 18:3 may therefore not represent the actual conditions but is to be taken to represent the conditions as they are now known to the present writer. In the second place, even with the fullest studies, the balance might be expected to be in favor of North America, partly because of the relatively greater development of the species of this section (*Sabina*) here than in Europe, but chiefly because of the larger number of species and far more complex development of the family Malaceae, the hosts of the alternate phases.

TABLE II.—DISTRIBUTION OF THE SPECIES OF GYMNOSPORANGIUM ACCORDING TO THE AECIAL HOSTS AND THE CONTINENTS

Aecial Hosts			Total No. of Species	North America	Europe	Asia	Africa
Order	Family	Genus					
Rosales	Malaceae (Pomaceae)	Crataegus	11	10	2	–	–
		Amelanchier	12	11	1	–	–
		Pyrus	7	3	2	2	–
		Malus	6	4	1	1	–
		Sorbus	6	4	3	1	–
		Aronia	4	4	–	–	–
		Cydonia	5	4	2	–	–
		Cotoneaster	2	–	2	–	–
		Pourthiaea	2	–	–	2	–
		Peraphyllum	1	1	–	–	–
		Mespilus	1	–	1	–	–
Rosales	Rosaceae	Porteranthus	1	1	–	–	–
Rosales	Hydrangiaceae	Philadelphus	1	1	–	–	–
		Fendlera	1	1	–	–	–
Pinales	Juniperaceae	Juniperus § Sabina	1	1	–	–	–

The suggestion of aecial hosts may lead to a consideration of table II. *Crataegus* and *Amelanchier* are seen to serve as hosts for many more species in North America than in Europe. This, it would seem, must bear some relation to the greater complexity and the more general distribution of these genera in North America. With regard to *Pyrus* the situation is entirely different, there being a total of 7 species known on this host almost equally divided between North America, Europe, and Asia. Certain other apparent discrepancies are at once understood when the distribution of the hosts is considered. *Aronia* and *Peraphyllum* serving as hosts only in North America are exclusively American genera; *Cotoneaster* and *Mespilus*, two hosts which are not recorded for North America, are not American genera; and *Pourthiaea*, recorded only for Asia is a strictly Asiatic genus.

RELATIONSHIPS BETWEEN THE ANTITHETIC HOSTS OF HETEROECIOUS SPECIES

By a comparative study of the various species of *Gymnosporangium* an attempt has been made to discover something which might give a clue to an explanation why the families Juniperaceae and Malaceae are so universally and almost exclusively utilized as hosts. Although the efforts have not been productive of any positive results, certain data seem worthy of presentation. It is a notable fact that there are only two known species which inhabit hosts outside of the families mentioned above, those being *G. exterum*, whose aecial host is *Porteranthus stipulatus*, an herbaceous plant of the family Rosaceae, and *G. gracilens*, whose aecial hosts are *Philadelphus* and *Fendlera* of the family Hydrangiaceae.

One suggestion which naturally presented itself in this study concerns the relation of the distribution of the hosts of the different phases. In many of the heteroecious rusts there occurs in one phase a stage which is capable of reproducing itself upon the host which bore it, and in such species it is obvious that the distribution of the phase possessing this repeating stage is not very dependent on the other phase. Consequently one phase might, if its hosts permitted, spread far beyond the distribution of the hosts of the alternate phase. Examples of this situation are so common as to scarcely need mentioning. It is a well-known fact that the black rust of wheat and other cereals and grasses is widespread in areas where the barberry bush is unknown. Another conspicuous example is the leaf rust of rye which is common in North America but which has its alternate phase on a member of the Borage family which is practically unknown in North America, and the alternate stage has never been detected on this continent.

As has been previously stated, the genus *Gymnosporangium* possesses no such repeating stage in the present known species and the result is that the association of the hosts of the alternate phases is a necessary condition for the perpetuation and distribution of the fungus. It is well known that the mycelium of the telial stage of many species is perennial, and it has been claimed in certain instances that the mycelium of the aecial stage may be perennial (von Tubeuf 1907), but since the mycelium cannot spread from one individual host to another the distribution of the species is still dependent on the association of the alternate hosts. As to just how close this association must be, no very definite limit can be set. The spores, doubtless, under usual conditions can be blown for distances varying from a few feet up to several miles. Thaxter (1891) mentions a case where he is certain that infection resulted from spores blown about eight miles. It is not probable that either under the most favorable or unusual conditions that spores could be carried any very great distance and we are therefore in a favorable position to study the comparative distribution of the alternate hosts in this genus.

The studies have been confined to North America and necessarily of course to those species which are known in both phases, eighteen having been selected for this purpose. While not yielding any results from which impartant generalizations may be made, it may be worth while to present some of the facts as follows:

A. Geographic distribution of the two sets of hosts very similar or almost coinciding—
    (1) *G. Juniperi-virginianae*, (2) *G. globosum.*

B. Geographic distribution of the two sets not coinciding, one much restricted and included within the other—
  a. Range of aecial hosts included within the range of the telial hosts—
    (1) *G. trachysorum*, (2) *G. exterum*, (3) *G. floriforme*, (4) *G. juniperinum*, (5) *G. germinale*, (6) *G. corniculans*, (7) *G. exiguum.*
  b. Range of telial hosts included within range of aecial hosts—
    (1) *G. Botryapites.*

C. Geographic distribution which is common to both sets only a portion of the distribution of either set—
    (1) *G. Nelsoni*, (2) *G. Davisii*, (3) *G. inconspicuum*, (4) *G. Blasdaleanum*, (5) *G. Betheli*, (6) *G. clavariaeforme*, (7) *G. Nidus-avis*, (8) *G. cornutum.*

While it is impossible to escape the conviction that some extraordinary relationship must exist between the sets of hosts occupied by a heteroecious form in its alternate phases the above facts scarcely indicate that the two sets would have been selected because of geographic distributions as now existing. If similar distributions or constant associations of the antithetic hosts are in any measure accountable for their utilization, and it is possible to conceive that they may have had considerable determining power, it is most likely that it was the distribution in very early times, when these fungi were in an unstable and perhaps weakly parasitic condition, that may have had an effect. It seems that very little is to be gained from a study of present day conditions which have become altered by so many factors. The fact that so many species have the range of the aecial hosts included within the range of the telial hosts is noteworthy and calls attention to the fact that in this regard there is a resemblance to the conditions prevailing in most heteroecious species which possess repeating spores. It suggests that the species of *Gymnosporangium* are different from the other heteroecious rusts chiefly in the lack of repeating spores and that if in the past such a stage existed that this group would have conformed very well with other heteroecious groups.

TABLE III.—SHOWING THE NUMBER OF SPECIES ALTERNATING BETWEEN THE HOST GENERA OF THE TWO ANTITHETIC PHASES

AECIAL HOSTS		TELIAL HOSTS
Crataegus Amelanchier	7	● Juniperus § Sabina
Pyrus Cydonia	4	
Malus	3	
Sorbus Aronia Cotoneaster Fendlera Peraphyllum Philadelphus Porteranthus Mespilus Juniperus § Sabina	1	
Amelanchier Aronia Sorbus	3	● Juniperus § Oxycedrus
Crataegus Cydonia Pyrus Malus	2	
Cotoneaster	1	
Amelanchier Sorbus	1	● Chamaecyparis
Crataegus Amelanchier ?Pourthiaea	1	● Heyderia
Pyrus	1	● Cupressus

In order to gain some idea of the different "affinities" existing between the host genera of the antithetic phases, a study of the number of species alternating between the various antithetic hosts has been made and the data are graphically presented in table III. It is not likely, though, that the number of species alternating between two sets of hosts can be taken as a measure of the "affinity" or "relationship" existing between them, and yet the results of this compilation are not without interest and perhaps significance. In considering table III it must be borne in mind that oftentimes several genera serve as aecial hosts for a species, which with a single exception (*G. germinale*) is limited to one genus, or section, for its telial hosts. *Crataegus* and *Amelanchier*, serving as the hosts for 11 and 12 species, respectively, are very much in the lead of the other aecial hosts. As the conditions are now known from cultures, *Amelanchier* seems to be of a more generalized type, serving as host for species coming from 4 of the 5 sets of telial hosts while no other aecial host serves for more than 3 of the telial host-groups.

FACTORS AFFECTING THE DISTRIBUTION OF GYMNOSPORANGIUM

The data concerning the relation of the distribution of the fungi to the area over which they might be distributed, so far as host conditions are concerned, may be expressed thus:

A. Species of *Gymnosporangium* having known distribution within or practically coextensive with the area common to both sets of hosts—

  a. Distribution practically coextensive with area common to both sets of hosts—

    (1) *G. Juniperi-virginianae*, (2) *G. globosum*, (3) *G. Nidus-avis*, (4) *G. Nelsoni*, (5) *G. Davisii*, (6) *G. inconspicuum*, (7) *G. Blasdaleanum*, (8) *G. Botryapites*.

  b. Distribution in central part of area common to both sets of hosts—

    (1) *G. trachysorum*, (2) *G. exterum*, (3) *G. Betheli*, (4) *G. floriforme*.

    (Mostly little known species—when thoroughly collected may possibly belong under *a*.)

B. Species having known distribution in no apparent relation to area common to both sets of hosts, sometimes in isolated districts—

    (1) *G. clavariaeforme*, (2) *G. cornutum*, (3) *G. juniperinum*, (4) *G. germinale*, (5) *G. corniculans*, (6) *G. exiguum*.

From the foregoing data it becomes evident that the tendency is toward the distribution of the fungi over the entire geographic area which provides the necessary host conditions. Even with the numerous cases which appear to be exceptions the argument in favor of this tendency is still strong when the full data concerning the apparent exceptions are considered.

In the first place, we are not yet in a position to say just what the geographic distribution of some of the species of fungi really is because of insufficient field work. The four species (under A, b) which are said to be distributed in the central part of the area common to both sets of hosts are comparatively little known species. When they are thoroughly collected they will doubtless be found to have a broader distribution than that known at present. The six species (under B) cited as bearing no apparent relation to the area over which they might be distributed also need further investigation before definite conclusions can be drawn. *G. clavariaeforme*, for example, is known from Maine and Delaware west to Wisconsin and northeastern Iowa and also in Colorado and Wyoming. The host conditions are furnished in the area between these regions through Minnesota, North Dakota and Montana but so far as the writer knows the fungus has not been reported from any of these states. The proper association of hosts for this species also prevails clear across southern Canada, but the fungus has apparently not been collected in this whole area. Whether the lack of collections from these regions can be taken to indicate that the fungus does not occur there seems very doubtful. It is much more probable that it indicates lack of well directed efforts toward collecting. *G. juniperinum* appears to furnish a much better example of a possible exception to the tendency of distribution over the common host area than do any of the other species listed above. The hosts of this species, *Sorbus*, and *Juniperus* § *Oxycedrus* are associated together from Labrador across southern Canada and the great lake region to the Rocky Mountains but the fungus is only known in the Rocky Mountain region from Alberta and British Columbia south to Colorado.

Taken as a whole the evidence regarding the distribution of the heteroecious species in this group indicates that the association of the two sets of hosts furnishes the necessary conditions for the growth of the fungi and that wherever this association prevails we may expect, either now or eventually, to find the fungi. There is practically nothing to indicate that other factors such as temperature, amount of precipitation, or character of the soil have any direct influence on the distribution of the fungi. It is well known that junipers and cedars occur in diverse climates and on widely different soils, and on hosts in all these varying conditions the fungi thrive. Whether the host occurs in a warm region on a permeable sandy soil or in a colder place on wet marshy ground it is apparently equally susceptible to these fungi. The amount of rainfall and the temperature prevailing during the germinating time of the teliospores in the spring might have a seasonal or local influence on the prevalence of the fungi and in this indirect way these factors might have a slight but unimportant bearing on distribution.

EVOLUTIONARY TENDENCIES

Regarding pleomorphism and heteroecism there is no evidence brought forth by the investigation of this group which is of significance except as it is interpreted in the light of our present knowledge of other groups of Uredinales. There is, on the one hand, the view that the species with only two spore-forms (the so-called micro- and lepto-forms) are the most primitive (Dietel, 1899) and that the other species with more spore-forms (hemi-, brachy-, opsis-, and eu-forms) have been derived from them. Along with this view of pleomorphism, goes the generally conceived idea that autoecism is the primitive condition, heteroecism being considered a later adaptation (Klebahn, 1904). Opposed to these views, is the theory that pleomorphism and heteroecism are really the primitive condition of the order (Arthur, 1906, Blackman, 1904). This latter theory assumes that the production of the four spore-forms now known in the full life-cycle (eu-forms) was a very early condition in evolution and that the forms now extant with fewer spore-forms have been reduced by later influences. Similarly autoecism is derived from heteroecism by a reduction process.

It is not necessary to review here all the observations upon which these views are founded. Neither of the views explains the real origin of the group, but simply attempts to express the trend of evolution since a time when the group attained a more or less definite morphology and a parasitic mode of life. No assumptions need be made concerning what took place prior to this time in order to make out relationships between the various forms as they now exist. We are not so much concerned wth the question as to how these organisms acquired the parasitic mode of life and developed into the form which we recognize as rusts, but rather as to whether the simpler types, as we know them, represent primitive or reduced forms.

The observations made in the course of the investigations of the genus *Gymnosporangium* appear to support the latter theory. *i. e.*, that the trend of development is toward reduction in the number of spore-forms and toward autoecism. The facts which have led to this interpretation may properly be considered at this time.

In most of the groups or tribes of Uredinales the four-spored* condition is common and in many the larger number of species belong to that class, but in *Gymnosporangium*, as has already been pointed out, a three-spored condition is wholly dominant, repeating spores (urediniospores) being lacking in present known species. It is evident, then, that the species of *Gymnosporangium* stand apart from four-spored forms either as more primitive or as somewhat reduced forms. Certain facts gained from morphology and others from life-histories have assisted in forming a judgment on this point. The roestelia-type of aecium, which prevails in the genus, certainly cannot be looked upon as primitive. With its elongated membranous peridium, made up of highly specialized peridial cells, and its colored aeciospores with their evident germ-pores, the roestelia-type of aecium is surely to be looked upon as a later development than the cupulate-type of aecium, such as prevails in the pucciniaceous forms. This being the case the presence of aecia of the ordinary cupulate-type in the genus *Gymnosporangium* may be regarded as a safe means of determining which are the more primitive species within the genus, and in this way we may throw some light on the more general problem.

G. Libocedri (see *G. Blasdaleanum* in part 2) a species of western America on *Heyderia decurrens* (better known as *Libocedrus decurrens*) has been shown by cultures to be related to *Aecidium Blasdaleanum*, an aecial form of the ordinary cupulate-type, on *Amelanchier* and *Crataegus*. This is the only experimental proof which we have of a relationship between a cupulate aecium and a species of *Gymnosporangium*, but by analogical reasoning it seems most certain that *Aecidium Sorbi*, another cupulate form, must also be related to a *Gymnosporangium* on some host belonging to the *Juniperaceae.* The writer has explained in some detail in another paper (Kern, 1910[1]) that there is within the range of *Aecidium Sorbi* no known *Gymnosporangium* to which it may belong, but that there is in very close association with it a cedar-rust in the form of *Uredo nootkatensis* on *Chamaecyparis nootkatensis* and that there is strong probability of a relationship between these two forms. This hypothesis is supported by inferences drawn from analogy, homology, and certain features in their geographic distribution. *Uredo nootkatensis* is an undoubted uredinial stage and from its host affinities its connection with a *Gymnosporangium*-like telial form is naturally to be anticipated.

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* In using this expression the writer refers to those forms sometimes called *eu*-forms. The four spore-forms are pycniospores, aeciospores, urediniospores, and teliospores.

In this way we come to the belief that a uredinial stage does occur within this group and that there is the strongest kind of evidence that it occurs in a species which has the cupulate-type of aecium, or, in other words, in a species which must be looked upon as primitive. There is also evidence indicative of the possession of other primitive characters. Since *G. Libocedri*, whose aecial stage is of the cupulate-type, has a small foliicolous telial stage, not causing any hypertrophy, we may by analogy predict a similar telial stage for the *Uredo nootkatensis-Aecidium Sorbi* combination. In considering the telial characters, it should be said, there is every reason to regard the small foliicolous forms which cause no hypertrophy as the most primitive, and the forms which occur on the branches with fusiform swellings and those which induce special gall-like outgrowths, as relatively more and more specialized.

This very probable appearance of a uredinial stage only in a species which possesses other characters in both the aecial and telial stages of an undoubted primitive nature, the writer interprets as a support for the view that the presence of the uredinial stage is in itself a primitive character. According to this theory, the possession of the cupulate-type of aecium, foliicolous telia, and presence of uredinia are characters of the most primitive species of *Gymnosporangium*. The suppression of the uredinial stage and the assumption of some of its functions by the aecial and telial stages appear to have been the first step in reduction, while the reduction in the hosts, or autoecism, has taken place much later. There is but one autoecious species known, *G. bermudianum*, and according to the foregoing view it would stand as the most highly specialized representative of the group. The elongated, membranous type of peridium and the occurrence of both telia and aecia on galls fits in with this disposition.

The intimation that some of the functions of the uredinial stage have been taken over by the aecial and telial stages may be briefly explained. The chief function of the uredinia is to insure distribution by a rapid and extensive dissemination of the fungus. The long tubular peridium of the roestelia-type contains many more spores than the short cupulate-type and in this way larger dissemination is made possible. In many of the species of *Gymnosporangium* the telial stage has become perennial, and in this way continuity is insured, even though dissemination might be less rapid. The writer does not wish to convey the understanding that the assumption of the ordinary functions of the uredinial stage by the other stages is to be regarded as the influence which has suppressed the uredinia. The partial fulfillment of these functions by other stages may, on the other hand, be the result and not the cause of the disappearance of the uredinia. We are ignorant of the cause of suppression or reduction, but the disappearance of the uredinial stage and the development of new devices to perform its ordinary functions seem in some way to be correlated.

3. Experimental Investigation of Life-Histories

HISTORY

The species of *Gymnosporangium* were among the first heteroecious rusts in which a positive connection between the two alternating phases was experimentally proved by controlled inoculations. In the spring of 1865 Oersted (1865) showed by means of cultures carried out in the Botanical Garden in Copenhagen that the two fungi, *Gymnosporangium Sabinae*, inhabiting red cedar, and *Roestelia cancellata*, inhabiting the pear, were really but two phases in the life-history of a single organism. Oersted states that he had suspected this relationship in 1862 but was unable to actually carry out the experiment until 1865. It is interesting to note that he also suspected a similar connection between *Puccinia graminis* and *Aecidium Berberidis*, and in his communication describing his successful cultures with the cedar and pear rusts, June 10, 1865, he suggested that the same relation doubtless existed between the cereal and barberry rusts. On

June 15, 1865, after his paper had been sent to the printer he received word from DeBary concerning his successful culture with *Puccinia graminis* and *Aecidium Berberidis.* To Oersted, therefore, as well as DeBary we are indebted for much of the pioneer work with the heteroecious rusts. He was especially concerned with the species of *Gymnosporangium*, following up his earliest work with the demonstration of the life-history of "*Gymnosporangium juniperinum*" [*cornutum*] in 1866, and of *G. clavariaeforme* in 1867.

This early work showed such a new departure in development that contemporary botanists scarcely ventured to accept such a strange story and one can find skepticism even in the early writings of some who are still living. It is, therefore, not surprising that considerable time elapsed before additional work was done along this line. It was about fifteen years before further cultures were made with the cedar rusts by Hartig, in Germany, a little later by Farlow and Thaxter in this country, and by Plowright in England. Since that time this work has been further advanced by a number of investigators, among whom may be mentioned Barclay, Shirai, Fischer, Arthur, Yamada and Miyake, and others.

Necessity of Cultures

The fact having been once established that some of these fungi have their life-cycle divided into two distinct alternating phases, which inhabit wholly different and unlike host plants, the necessity of experimental cultures to supplement the former method of observation and description becomes at once apparent. The local association of any two such alternating phases in nature may lead one to suppose that the phases are related, but it requires actual cultures to show whether the supposition is correct or not. A culture in which a spore from one phase on one host is sown upon another host, and subsequently gives rise to a spore form of the alternating phase, is the only conclusive evidence that the two phases are related and represent different forms of the same organism.

Culture Methods

At this point it may not be out of place to describe briefly the methods which have been found most successful in cultivating the species of *Gymnosporangium.* In the first place it may be said that better results have been attained by sowing the teliospores from the cedars upon the malaceous plants as trial hosts and making observations for the appearance of the aecial generation rather than the converse. The reason for this lies in the different nature of the telial and aecial phases. The teliospores are mature in spring and germinate at once. Following an inoculation from teliospores the first sign of infection, the pycnial stage, is to be expected in six to twelve days, while the second sign, the aecial stage, may be looked for in one to four months, the actual time varying with the different species. In this way the cultures are carried on during the normal growing season and results obtained before the close of the season. The converse cultures in which the aeciospores are sown upon the cedars require a much longer incubation period, at least through one winter season, and possibly through two in some species. This latter method being more tedious and less likely to result in infection is not so satisfactory for working out life-cycles, and yet it may have certain advantages that will be mentioned later.

It is possible to carry on cultures out-of-doors but owing to the many disturbing factors such as danger from outside infection, accidental destruction of the trial host and many others the writer has practically abandoned them in favor of indoor cultures. For indoor experiments small but vigorous growing potted plants are most desirable. Some of the earlier investigators used cut branches with the ends placed in water, and detached leaves in moist chambers, but it is impossible to keep these in fresh condition for a sufficiently long time. The use of rooted plants which must be kept growing vigorously in pots for several months makes it necessary to carry on the work in a greenhouse, the conditions being too unfavorable and artificial for vigorous growth except under glass.

In making the inoculations the writer now employs the method of suspending a portion of the branch or the gall bearing the telia over the trial host in such a manner that the basidiospores (sporidia) will fall naturally upon the desired area, either young leaves or shoots, or developing fruit, according to whether the form is supposed to be chiefly foliicolous, caulicolous, or fruiticolous. The whole is then sprayed thoroughly with a fine spray from an atomizer. Care is taken to thoroughly moisten the telia. Sometimes the twig or branch bearing them is immersed in water and allowed to remain a few moments, all excess water being taken off before putting it in place. If the leaves of the trial host will not moisten they are rubbed between the fingers until the moisture will adhere. The plant is then covered with a bell-jar and set in a shaded place for a period of two or three days. The bell-jars are temporarily removed each day, aired and sprayed on the inside before being replaced. The bell-jar prevents rapid evaporation, thereby insuring the necessary moisture during the germination and infection period. During this period the plants are screened from the direct rays of the sun to prevent the temperature from rising too high. This scheme of first applying moisture to telia at the time when the sowing is to be made and of suspending the whole twig or gall directly over the parts to be infected has been found vastly better than that of removing the telia or spores, placing them in water and allowing them to germinate, and then attempting to apply the basidiospores with a brush or otherwise, as was first attempted by the writer following the lead of the earlier workers. One objection to the method as outlined above is that in the case of vigorous germination infection on a very susceptible host may be so great that the host may be severely injured by it and its further development checked. This may sometimes be overcome by washing off some of the basidiospores which can often be observed on the leaves of the trial host as a yellow powder. It is not necessary to make special tests for the germination of the spores, as is usually done with other genera of the rusts, for germination can nearly always be detected by the yellow and pulverulent condition of the surface of the spore-masses, if the aggregations of basidiospores cannot be seen by the naked eye on the trial host leaves as indicated above. In case of doubt a microscopic examination of some spores removed from a telium would soon settle the question. The species of *Gymnosporangium* are usually easy to bring to germination and yet some species have given considerable trouble and one species refused to germinate at all although the material was fresh and seemed in good condition.

Collection and Care of Culture Material

Telial material to be used for cultures is best when not collected until mature, and then used for sowing as soon afterward as possible. If fairly large specimens of the branches or twigs with some green leaves are secured, the telia will keep fresh for some time provided they are not allowed to become expanded with moisture.

Such specimens can be sent through the mail or express and be received in good condition, even after a long journey, if precaution is taken to wrap them in waxed paper such as florists use. I have received specimens from Europe in this way which were in a good viable condition. Specimens which have reached maturity in the field and have expanded after a rain and partially germinated are never so desirable as those which have never been expanded and gelatinized. Specimens which have been thoroughly dried for herbarium purposes are useless for culture work.

AUTHOR'S EXPERIMENTAL WORK

Five seasons[1] of culture work with the species of *Gymnosporangium* have been carried on as a part of the investigations summarized in this paper. Out of a total of 33 species now recognized in their telial phase, 26 have been available for the culture work. Successful cultures were secured in 18 of the 26 species tested. Of these, 9 were verifications of life-cycles previously ascertained and 9 gave aecial and telial connections never before recorded. In this work 233 individual plant cultures were attempted and 25 species of trial hosts were employed, belonging chiefly to the apple family, Malaceae (*i. e.*, Pomaceae). The following is a brief summary of the results of the work during the different seasons:

	1906	1907	1908	1909	1910	Total
Number of species of *Gymnosporangium* employed	3	10	16	12	11	26
Number of species successfully cultivated	3	8	11	11	5	18
Number of species cultivated for the first time	1	2	3	3	0	9
Number of plant cultures attempted	27	50	72	51	33	233
Number of species of trial hosts employed	10	13	16	17	13	25

SUMMARY OF ORIGINAL CULTURES

In order to bring together the scattered results pertaining to the cultures of *Gymnosporangium*, a table has been prepared giving a record of the first cultures of those species whose life-histories

[1] The sixth season has been progressing as this paper has been going through the press. Three new life-cycles have been worked out. See accompanying table of "Record of First Cultures" for details. The statistics as given above do not include the present season.

are known. A large amount of work for purposes of verification or extension of the range hosts has been done which it is impossible to mention here. In a few instances confirmatory cultures are mentioned when they have been the first ones made with American material or when the first cultures were inconclusive. The plan of this table is to indicate, first, the year when the work was performed, and secondly, the species of *Gymnosporangium* and its host, whenever that can be made out from the original report. Sometimes this information is not given directly, but if there is anything which leads to an inference I have included the possible host, using brackets to indicate that it is my insertion. Regarding the names, I have for the most part employed the name used by the original investigator, but for the sake of making it readily comparable I have in most instances inserted parenthetically the name applied to that form in this paper. Thirdly, the successful trial host, or hosts, and the aecial name of the resultant form, are given. This latter space is necessarily blank in many instances where the resultant aecial phase was never recognized and named as an independent form. The fourth column contains the name of the investigator and the reference to the original report. In some cases two names are given, separated by a semicolon, the idea being the same as where this method of citation is used in connection with the publication of a name, *i. e.*, that the first is largely responsible for the work and the second for the publication.

Record of the First Cultures Proving Relationships between the Species of Gymnosporangium and Their Alternate Phases

Year	Species of Gymnosporangium Host of Culture Material	Trial Host Species of Roestelia	Investigator Place of Publication
1865	G. Sabinae [J. sabina]	Birnbaum [Pyrus] R. cancellata	Oersted, Bot. Zeit. **23**: 291. 1865.
1866	"G. juniperinum" [cornutum] Juniperus	Sorbus aucuparia R. cornuta	Oersted, Overs. Danske. Vid. Selsk. Forh. **1866**: 185–196. 1866.
1867	G. clavariaeforme [Host not given]	Weissdorn [Crataegus] Apfelbäumen [Malus] R. lacerata	Oersted, Bot. Zeit. **25**: 222. 1867.

1882 (or earlier)	"G. tremelloides" [juniperinum] [J. communis]	Sorbus aria Sorbus chamaemespilus Malus Malus R. penicillata	Hartig, Lehr. Baum-Kr. 133. 1882.
1883	"G. clavipes" [germinale] [J. virginiana]	Amelanchier Pyrus Malus Pyrus arbutifolia	Farlow (inconclusive), Proc. Am. Acad. **20**: 313–315. 1885.
1883	G. globosum [J. virginiana]	Crataegus Pyrus Malus	Farlow (inconclusive), Proc. Am. Acad. **20**: 312–314. 1885.
1885–1887	G. confusum [Mespili] J. sabina	Crataegus oxyacantha Aecidium Mespili	Plowright, Brit. Ured. & Ustil. 232. 1889.
1886	"G. biseptatum" [Botryapites] [Chamaecyparis thyoides]	Amelanchier canandensis R. Botryapites	Thaxter, Proc. Am. Acad. **22**: 263. 1887.
1886	G. clavariaeforme [Host not given]	Crataegus tomentosa	Thaxter (verification in America), Proc. Am. Acad. **22**: 262. 1887.
1886	"G. clavipes" [germinale [J. virginiana]	Amelanchier canadensis R. aurantiaca	Thaxter, Proc. Am. Acad. **22**: 264. 1887.
1886	G. globosum [J. virginiana]	Crataegus coccinea	Thaxter, Proc. Am. Acad. **22**: 263. 1887.
1886	G. Nidus-avis [J. virginiana]	Amelanchier canadensis	Thaxter, Proc. Am. Acad. **22**: 264. 1887.
1886	G. Juniperi-virginianae [J. virginiana]	Pyrus Malus R. pyrata	Thaxter, Proc. Am. Acad. **22**: 262. 1887.
1889	G. Cunninghamianum Cupressus torulosa	Pyrus Pashia	Barclay, Sci. Mem. Med. Off. India **5**: 76–78. 1890.
1897	G. japonicum J. chinensis	Pyrus sinensis R. koreaensis	Shirai, Zeits. Pflanzenkr. **10**: 1–5. 1900.
Prior to 1901	"G. flaviforme" [floriforme] J. virginiana	Crataegus spatulata	Thaxter; Earle, Contr. U. S. Herb. **6**: 186. 1901.
1906	"G. Nelsoni" [juvenescens] J. scopulorum	Amelanchier canadensis Sorbus americana	Arthur (Kern), Jour. Myc. **13**: 203. 1907.

1907	G. Betheli J. scopulorum	Crataegus coccinea Crataegus punctata R. Betheli	Kern; Arthur, Jour. Myc. **14** 23. 1908.
1907	G. Miyabei Chamaecyparis pisifera	Pyrus Miyabei Pyrus Aria R. solitaria	Yamada & Miyake, Bot. Mag. **22**: 21–28. 1908.
1907	G. inconspicuum J. utahensis	Amelanchier erecta R. Harknessianoides	Kern; Arthur, Jour. Myc. **14**: 24. 1908.
1907–1909	G. Amelanchieris Juniperus communis Juniperus nana	Amelanchier ovalis R. amelanchieris	Ed. Fischer, Zeits. f. Bot. **1**: 683–714. 1909.
1908	G. Davisii J. Sibirica	Aronia nigra	Kern; Arthur, Mycologia **1**: 241. 1909.
1908	G. exterum J. virginiana	Portherantus stipulatus	Kern; Arthur, Mycologia **1**: 253. 1909.
1908	G. cornutum Juniperus sibirica	Sorbus americana	Kern; Arthur (verification in America), Mycologia **1**: 240. 1909.
1908	"G. Libocedri" [Blasdaleanum] Libocedrus decurrens	Crataegus Pringlei Aecidium Blasdaleanum	Kern; Arthur, Mycologia **1**: 252. 1909.
1909	G. corniculans J. horizontalis	Amelanchier erecta Amelanchier canadensis	Kern; Arthur, Mycologia **2**: 235. 1910.
1909	G. exiguum J. virginiana	Crataegus	Kern; Arthur, Mycologia **2**: 234. 1910.
1909	G. trachysorum J. virginiana	Crataegus cerronis	Kern; Arthur, Mycologia **2**: 236. 1910.
1911	G. speciosum [gracilens] J. monosperma	Philadelphus coronarius	Cultures now in progress
1911	G. Nelsoni (=durum) J. scopulorum	Amelanchier	Cultures now in progress
1911	G. Kernianum	Amelanchier	Cultures now in progress
	G. bermudianum	No cultures—	Autoecious

Unattached Forms

In addition to the above species, whose life-histories have been experimentally demonstrated, there are a number of isolated forms, which, from their morphologic characters, clearly belong in this group. Some of these are known only in the telial phase, others only in the aecial phase. The following is a list of these unattached forms recognized in this paper:

Aecial phase unknown	G. Ellisii	on Chamaecyparis	North America
	G. fraternum	" "	
	G. effusum	on Juniperus (§ Sabinae)	
	G. multiporum	" " "	
Telial phase unknown	G. Harknessianum	on Amelanchier	
	G. transformans	" Aronia	
	G. hyalinum	" Crataegus	
	G. tubulatum	" "	
	G. Sorbi	" Sorbus	
	G. Photiniae	" Pourthiaea	Japan
	G. Yamadae	" Malus	

CLUES OF RELATIONSHIP

For most of the above forms there are no definite clues of probable relationships. Some of the telial and aecial phases may belong together, or, on the other hand, the alternate phases of the forms here listed may still be undetected. *G. Ellisii* has been thought by some to be connected with *G. transformans*, but this has never been demonstrated. The writer (Kern, 1910[1]) has suggested that *G. Ellisii* is more likely related to *G. hyalinum*. *G. Harknessianum* is a very striking form from California. It is similar in habit and external morphology to the aecia of *G. inconspicuum*, and by analogical inference I would suggest that it is probably related to an inconspicuous telial form occurring on the green branches, not causing hypertrophy, and having teliospores with carotiform pedicels. It is possible that *G. Sorbi* may turn out to have the most interesting life-cycle of all, if it should be related to *Uredo nootkatensis* on *Chamaecyparis nootkatensis*, as I have previously suggested (Kern, 1910[1]). For the two Japanese forms I am unable to make any suggestions.

In addition to the unattached aecial forms listed above, there is another form from Japan, *Aecidium Pourthiaeae* Sydow, on a malaceous host, *Pourthiaea villosa*, which doubtless has a cedar-rust for an alternate stage and belongs in this group. In structure and habit this form is so similar to the North American species, *G. Libocedri* (*Blasdaleanum*), which is connected with a telial form on *Heyderia decurrens* (generally referred to as *Libocedrus decurrens*) that it has been thought best to treat it as a doubtful synonym of that species until cultures can definitely determine its relationship. The fact that there is in the Orient another species of the genus *Heyderia*, which might harbor the telial stage there, lends support to the above suggestion.

DEVELOPMENT OF THE TELIAL STAGE

The telial stage of a number of species, especially those producing fusiform swellings on the branches, has long been known to be perennial, but Plowright (1889) was the first to show by means of cultures the nature of the early development of such a form. He found in experimenting with *G. clavariaeforme* that the "aecidiospores require two years in which to perfect the development of perennial teleutospore mycelium." Aeciospores were sown upon a juniper on June 25, 1884; about two weeks later some of the leaves turned yellow and during the autumn these fell off leaving bare places on the branches. The juniper remained in this condition until December, 1885, when the bare branches showed signs of swelling, and the following spring, April, 1886, telia were produced. More recently, Heald (1907, '09) working with *G. Juniperi-virginianae* (*G. macropus*), the common cedar-apple in eastern North America, has shown by careful observations that it most likely develops in a similar manner. Heald found very young cedar-apples about the size of radish seeds to be present on the cedars in June some days before any mature aeciospores could be detected and this led him to suspect that these young galls were the result of infection from aeciospores of the previous season, and since his observations showed that they did not bear spores until the following spring it seemed most likely that this mycelium must require nearly two years to develop a cedar-apple bearing spores. Observations of the writer substantiate this view.

It would seem, therefore, that whether the mycelium is perennial, *i. e.*, remains alive in the cedar and produces spores for several successive seasons, or whether it dies after having produced a single season's crop, that it may in either case be developing for two years before bearing spores. Further investigations along this line are necessary in order to determine what the nature of the development of the mycelium in the different species really is. Biennial maturation may be the rule in species which have the telia appearng on the twigs or branches, causing hypertrophy, and also in those where the telia develop special outgrowths or gall-like excrescences, but there are a number of forms where the telia occur on the leaves or young branches in which there is some reason for believing that the maturation is annual, spores developing in the spring from an infection of the previous summer. It is altogether probable that the development of the fungus may not require any definite length of time with respect to the seasons directly, except in so far as it is dependent upon the growth of the host, which is, of course, influenced by the seasonal changes. It is further possible that the time and place of infection may have an influence upon the rate of growth of the mycelium. This is an interesting field in which further experimental data are desirable.

4. Pathologic and Economic Importance

Pathologic Effects

The anatomic changes induced in the host-tissues by the mycelial growth of the species of *Gymnosporangium* are in general more noticeable in the telial than in the aecial hosts. Some of the species, it is true, produce their sori on the leaves of the cedars and junipers without causing material deformations, but the majority of the species cause twig-deformations either of the nature of gradual swellings or of abrupt gall-like swellings. Other species induce malformations of the branch-systems commonly known as witches' brooms. Woernle (1894) has especially investigated the changes induced in the internal morphology of the telial hosts. In the case of *G. clavariaeforme*, which causes gradual fusiform swellings of the branches, he found increased growth in the xylem, phloem, and cortex, the largest increase taking place in the phloem. The medullary rays were found to be more numerous and somewhat higher than usual; the wood parenchyma was more abundant; the tracheides no longer followed a straight course and had numerous intercellular spaces between them. The mycelium filled the phloem and cortical regions and sometimes formed masses in the intercellular spaces. An examination by the same investigator of similar swellings induced by other species of *Gymnosporangium* revealed the same general pathologic effects in the tissues. In most of the hypertrophied areas the limits of the annual growth-rings were difficult to make out, and in the swellings produced by *G. Sabinae* a yellow pigment was found deposited in the walls of all the elements. It is interesting to note that the scar left by the fall of the spore-masses (telia) is covered by a scar-tissue consisting of several layers of cork-cells, and that the new spore-masses forming in succeeding years rarely break through this cork layer of an old scar but issue through some new portion of the bark. Some of the typical gall-producing forms arise as outgrowths from branches or twigs (as *G. globosum* and *G. Nelsoni*) while others may have their origin in the leaves. *G. Juniperi-virginianae* and *G. floriforme* are examples of species which produce galls that originate in the leaves. Sanford (1888) investigated the changes which are induced in leaf-tissues by the formation of a globoid or reniform gall of *G. Juniperi-virginianae* with the following results: the most striking change is in the great multipication of cells and their generally enlarged size; the cell-walls are thicker than normal and behave toward cytological reagents decidedly like fungous tissue; the vascular system is developed until it is as important as in a branch and divides in a peculiarly radiating manner, the elements of the bundle become distorted and irregularly placed; and the epidermal system of the leaf entirely disappears, its place being taken by layers of cork-cells covered over by a thin layer of dead shrivelled cells.

The aecial phases appear on the leaves, petioles, twigs and fruits of their hosts. Occurrence of the aecia on the leaf blades is usually accompanied by an increased thickness caused by a multiplication of the cells of the spongy parenchyma and the frequent arrangement of the upper ones into palisade-like layers. Fentzling (1892) in examining pear leaves attacked by *G. Sabinae* reported a radial elongation of the cells of the spongy parenchyma and a partial formation of cork. On the other hand Wakker (1892) in an investigation of the twigs of *Crataegus* infected with *G. clavariaeforme* reported that the formation of cork was inhibited, as well as collenchyma, sclerenchyma and chlorophyll. He also found that lignification of the cells of the medullary rays is interfered with, that activity of the intrafascicular cambium is suspended at a very early stage and that interfascicular cambium is not formed. Starch is stored in large quantities in the hypertrophied regions. Some investigators report an increased deposit of calcium oxalate while others find that its formation is diminished. The aecia occurring on some of the smaller fruits, as those of *Crataegus* and *Amelanchier* often occupy the whole of the surface of the fruit. In this case the ovules become completely blighted, the production of seed being entirely prevented. It is interesting to note that these affected berries show the same abnormal tendency to hang on as do fruit-mummies caused by the attacks of other fungi. On larger fruits such as apples, pears, and quinces the infected area is often only a portion of the surface but the fruit is always dwarfed and often distorted.

The leaf-inhabiting forms, aside from the injury caused by the arrest and utilization of food-materials, may work a still greater injury to the health of the host by bringing about a premature defoliation. In severe infections of apple trees it sometimes happens that the leaves fall before the aecia have time to mature. Heald (1909) reports that in severe cases an ordinary apple leaf may have as many as 200–300 separate points of infection.

ECONOMIC IMPORTANCE

The importance of the members of the apple and cedar families is so great economically that any factors causing disturbances in their health are worthy of consideration. Orchardists have been aware for some time that certain species of rust (*Gymnosporangium*) often attack the stable orchard crops, such as apples, pears, and quinces, in a very virulent and destructive manner. It is not so well appreciated that many of the wild and native species of the apple family which are being used for decorative puposes are also susceptible to rust-diseases, especially when planted in proximity to members of the cedar family. The importance of these rusts from the standpoint of the cedars has, perhaps, been still less appreciated, at any rate it has been much less emphasized. Heald (1907), however, writes "those who have cedars—and there are many in this section [Nebraska] who value them as much as they do their apple trees—have been clamoring for assistance in saving them from the inroads of this fungus [*G. Juniperi-virginianae*]."

From the point of view of the orchard crops there are only a few of the species of *Gymnosporangium* which are of economic importance. *G. Juniperi-virginianae* (*G. macropus*) is the "orchard rust" of American horticultural writers and is the commonest species occurring on apple in this country. It attacks the leaves chiefly but not infrequently the young fruits also become infected. The common aecial hosts of this species are the wild crab-apples, and it is interesting to note in this connection that although the cultivated apple has been attacked for many years in the eastern United States, it is only in recent years that this fungus has appeared on the cultivated apple in the central states. In discussing an outbreak of apple rust in Iowa during the summer of 1905 Pammel made the following statement, "In my observations and experiments, extending over a period of fourteen years in this state, I have never [before] seen the cultivated apple affected. That it may become a very serious enemy to apple culture in the state cannot be doubted." His prediction has been fulfilled. *G. globosum*, most commonly found on the hawthorns (*Crataegus*), also attacks the leaves of the cultivated apple in the New England states. So far as the writer knows, it has been reported on that host only from Maine, Vermont, Massachusetts, Connecticut and New York. In Europe *G. juniperinum* (*G. tremelloides*) is the only species which attacks the apple. In parts of Europe, especially northward, it is often reported as abundant and severe. Although this species also occurs in America it has not yet been found here on the apple.

The pear (*Pyrus communis*) is occasionally attacked in the eastern United States by *G. globosum* which is usualy confined to the leaves. Stewart (1910), who has had under observation a Kieffer pear orchard on Long Island, N. Y., reports the presence of this rust each year since the trees were planted in 1903 and observes that prior to 1910 only the leaves were affected, while during the season of 1910 both leaves and fruit were severely attacked. *G. Sabinae*, of Europe, has the pear as its chief aecial host and its injury to pear culture there has long been recognized.

In America the quince (*Cydonia vulgaris*) is frequently attacked by *G. germinale* (*G. clavipes*) and more rarely by *G. Nidus-avis*, the former often producing injury of practical importance. Both quinces and pears have occasionally been attacked in Colorado by a roestelia which the writer has referred to *G. Nelsoni*. In Europe *G. clavariaeforme* and *G. Mespili* (*G. confusum*) attack the quince.

From the point of view of the genus *Juniperus* the species of *Gymnosporangium* just mentioned in the foregoing discussion of orchard crops are, perhaps, the more important, since they are the ones which are naturally most likely to occur on those red cedars and junipers which are used for wind breaks or for decorative planting in yards and gardens in the proximity of orchard trees.

There are, however, some species which are more injurious to the cedars than those which have their aecia on economic aecial hosts. *G. Betheli*, common on *Juniperus scopulorum* in the Rocky Mountains, is one of the most destructive species known. The white cedar (*Chamaecyparis thyoides*) is attacked by two species, *G. Botryapites* (*G. biseptatum*) and *G. Ellisii*, the former producing swellings of the trunk and branches and the latter witches' brooms, both often threatening the welfare of the trees.

CONTROL

Methods for the control of these, as well as most other rust-diseases are as yet uncertain or impracticable. Segregation of the members of the apple and cedars families will accomplish the result but is not always possible. In making new plantings, however, this suggestion is worthy of consideration on the part of farmers, orchardists, and landscape gardeners. Spraying as recommended for other fungous diseases has been tried with incomplete success by many different workers. Attempts have been made (1) to prevent teliospore germination by spraying the cedar when the spore-masses were expanded; (2) to prevent infection of the apple by basidiospores (sporidia) by spraying the apple trees just after teliospore germination (*i. e.*, after a rain); and (3) to prevent reinfection of the cedars by spraying them to inhibit aeciospore germination on them when the aeciospores are being distributed in the late summer (see Heald, 1909). Variable results seem to be obtainable depending upon the nature of the season and the judgment of the operator. The first two schemes are open to practical objection not only because spraying is necessitated after every rain for a considerable period in the spring but also because a delay of a few hours after the rain is sufficient to make the spraying useless. The third scheme is apparently an impossibility because of the long period during which spores are being discharged and the lack of any climatic conditions to indicate when distribution is going on. Another suggestion which has been made for the benefit of orchardists concerns the resistance of the varieties grown. This is without doubt deserving of attention as it has been shown (Stevens and Hall, 1910; Stewart, 1910; Lloyd & Ridgway, 1911) that the varieties of apples and pears differ very greatly in their susceptibility. This suggestion may not be so easily followed in practice, however, because the resistant qualities may not always be combined with other desirable characters. This then might become a problem for the coöperation of the plant breeder. The foregoing statement of the uncertainty and incompleteness of methods for the control of these and similar diseases is but an admission that one of the large problems of the plant pathologist is still unsolved.

PART II

TAXONOMY OF THE GENUS GYMNOSPORANGIUM

5. Introduction

Some of the species of the genus *Gymnosporangium* have been known scientifically since the earliest times. The fungus is said to have been mentioned by Franke in his "Speculum Botanicum" in 1638. It is certain that the description of Micheli's *Puccinia non ramosa* on junipers and cedars given on page 213, and the illustration on plate 92, of his "Nova Plantarum Generum" published in 1729 clearly belong to a species of *Gymnosporangium*. One of the few species of fungi described by Linnaeus in the first edition of the "Species Plantarum" in 1753 was a *Gymnosporangium* although of course not referred to by that name, but as a *Tremella*. Linnaeus had at a still earlier date, 1737, employed the name *Byssus* for these fungi in his "Flora Lapponica."

Much work has been done with the group and many papers have been published referring both to the biology and taxonomy of the species. In more recent years since the subject of phytopathology has been receiving considerable attention a great many notes on the economic importance of the group have appeared. The first study of a monographic nature of the genus was made by Farlow in 1880 in a paper entitled "The Gymnosporangia or Cedar-apples of the United States." This, as the title suggests, attempts to describe only American species. Dietel contributed the part on the Uredinales to Engler & Prantl's "Natürlichen Pflanzenfamilien" in 1897 in which he devoted three pages to the genus *Gymnosporangium*. He recognized 14 species in the world, 8 in North America, 5 in Europe, and 1 in India. In 1901, in a brief paper dealing chiefly with the question of nomenclature Arthur recognized 15 species of cedar-apples, of which he said 8 occurred exclusively in North America, 2 in both North America and Europe, 3 wholly in Europe, 1 in India and 1 in China and Japan. Descriptions of the various species have appeared in Saccardo's "Sylloge

Fungorum" from time to time but both that work and that of Dietel in the "Natürlichen Pflanzenfamilien" while bringing together the systematic information are in nature only compilations. There has therefore been a gradual accumulation of knowledge regarding the genus but no complete monographic study has appeared up to the present time.

As intimated in the prefatory note, this paper attempts to present a systematic treatment of all the species known to occur in any part of the world so far as the writer has been able to make them out from an examination of the literature and herbarium specimens, supplemented by extensive field studies in the United States. The present paper describes 29 species which have the full life-cycle known, 4 known only in the telial phase, and 7 known only in the aecial phase; a total of 40 species.

In preparing the descriptions the author has attempted to make them as brief as possible and still have them include the chief diagnostic characters. If in some instances they appear rather long it is because it is thought best not to sacrifice accuracy for the sake of brevity. Descriptions of the pycnia have been omitted under the different species because as a rule these structures do not present very important diagnostic characters. Pycnia are known in every species where the aecia are known (except *G. bermudianum*), and they have been examined and sectioned but since the characters are fairly uniform* it is thought that the generic description will suffice for this stage. Moreover, even with the fullest descriptions it would be impossible to determine specimens having only this stage present.

In the aecia, the form which the peridium takes on after dehiscence has been used as the chief gross character. Among the microscopic characters of first importance are the nature of the surfaces of the peridial cells and the relative thickness of their walls. The value of the peridial cell in defining the species has been pointed out by Dr. Ed. Fischer (1895), and the writer has also contributed a special paper (1910^2) on this subject. Concerning the surface characters of the peridial cells it may be well to quote from the latter paper where the descriptive terms to be used are fully explained: "With regard to the surfaces of the peridial cells, it has been found that the species so far recognized divide at first into two classes, one having entirely smooth cells, the other having at least a portion roughened. I have subdivided the latter class upon the nature of the roughness, and have used the terms rugose, verrucose, verruculose, and spinulose to designate the four classes. The terms used to designate the various classes are intended only to be descriptive in a general way. The rugosely sculptured cells are furnished chiefly with ridges or elongated ridge-like papillae in such a way that the effect is that of a surface covered with rugae or folds; the verrucosely marked cells are studded with warty or tubercle-like elevations; the verruculose surfaces are covered with low wart-like protuberances; the spinulose cells have diminutive spines or spicules. The markings always cover the entire inner wall extending to the side walls, in some forms reaching clear across, in others, only a part of the distance, leaving the outer part of the side wall and the entire outer wall, with rare exceptions, smooth."

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* It is possible to pick out certain species which might show considerable difference in the size of the pycnia, for instance in *G. germinale* they are 160–270µ in diameter by 150–230µ high, with ostiolar filaments 90–150µ long, while in *G. Nidus-avis* they are 120–155µ in diameter by 80–112µ high, with ostiolar filaments 45–65µ long. These are however extreme cases.

In the telial stage, the nature of the place where the telia appear is used as a gross character. Some occur on leaves or young branches not producing hypertrophy, others appear on fusiform enlargements of the twigs or branches, while others appear on galls or gall-like excrescences. The form of the telia is also a gross character of prime importance. The color of the mature telia before expansion and germination has been taken account of and is in many instances a good diagnostic character. No matter what the color is originally the telia always become yellowish upon germination. The telia are naked and the microscopic characters therefore lie wholly in the teliospores and pedicels, and consist chiefly of size, number of cells, location and nature of the germ pores, and shape and thickness of the pedicels. It may be said here that it has been pointed out by a number of workers (Körnicke, 1877; Dietel, 1889; Richards, 1889; Blackman, 1904) that some species of this genus possess two sorts of teliospores in every sorus, thick-walled ones and lighter colored thin-walled ones. Generally speaking these do not represent two classes but only two extremes, for all gradations can be found between the thickest walls and the thinnest. No attempt has been made to separate these in the specific descriptions and the measurements given are to be interpreted as the general average, not including, as a rule, either extreme. The theory has been advanced several times that the thin-walled spores might represent urediniospores but that view cannot be substantiated. It embodies a confused idea of the essential differences between teliospores and urediniospores. If the thin-walled spores put out long undivided germ-tubes as claimed, this must have been due to unusual conditions of growth, for it is well known that under certain special conditions, particularly when growing entirely submerged, the thicker-walled spores, also behave in this way.

6. Generic Description

Order UREDINALES

Family AECIDIACEAE

Genus GYMNOSPORANGIUM Hedw. f.; DC. Fl. Fr. **2**: 216. 1805

Cycle of development includes pycnia, aecia, and telia, with distinct alternating phases; heteroecious and autoecious. Pycnia and other sori subepidermal.

Pycnia deep-seated, usually globoid, generally prominent and conspicuous, at first honey-yellow, usually becoming blackish, globose or flattened globose, with ostiolar filaments.

Aecia erumpent, at first cylindric. Peridium dingy white, in a few species short and cupulate but usually elongated into a more or less tubular form, membranous, tending to rupture by longitudinal slits along the sides; peridial cells imbricated and often articulated, occasionally hygroscopic becoming curved when wet, outer walls smooth (except in a few species), rather thin (except in *G. hyalinum*), inner and side walls smooth, verruculose with low wart-like protuberances, verrucose with warty or tubercle-like elevations, rugose with ridges or ridge-like papillae beginning on the inner wall, directed downward and outward and extending obliquely on to the side walls, or spinulose with diminutive spines or spicules, usually rather thick. Aeciospores globoid to broadly ellipsoid, wall colored, verrucose, usually with numerous, scattered, evident germ-pores.

Telia erumpent, naked, usually definite, variously shaped, gelatinous and elastic at maturity, expanding considerably when moistened. Teliospores chiefly 2-celled, in some species 3-, 4- or 5-celled, by transverse septa; walls colored, of varying thickness, smooth; pores usually 2 in each cell, sometimes 1, 3 or 4, variously arranged, often near the septa, sometimes apical in the upper, rarely near the pedicel in the lower (numerous and scattered in *G. multiporum*); pedicels hyaline, elastic, usually of considerable length, cylindric (carotiform in *G. inconspicuum* and *G. germinale*), walls thick, the outer portions swelling and becoming gelatinized in moisture to form a jelly-like matrix in which the spores appear imbedded.

Type species, *Gymnosporangium conicum* Hedw. f. (said to be on both *Juniperus communis* and *J. sabina*).

7. Analytic Keys

A. AECIA EXCLUSIVELY CONSIDERED

Heteroecious, aecia inhabiting Malaceae (except Nos. 21 and 24).
  Aecia short, cupulate, peridium lacerate or erose.
    Aeciospores small (12–23μ), wall thin (1–1.5μ). 1. *G. Blasdaleanum.*
    Aeciospores large (23–39μ), wall thick (3–4μ). 2. *G. Sorbi.*
  Aecia elongated, tubular at first (except in No. 27), in some species becoming altered by dehiscence.
    a Peridium retaining tubular or cornute form, unaltered by dehiscence.
      Peridium finally dehiscent at apex, slightly or not at all lacerate along the sides.
        Peridial cells verrucose.
          Side walls of peridial cells verrucose only on inner third. 4. *G. inconspicuum.*
          Side walls of peridial cells verrucose over entire surface.
            Aeciospore wall cinnamon-brown. 5. *G. Harknessianum.*
            Aeciospore wall pale yellow. 24. *G. gracilens.*
        Peridial cells spinulose or subspinulose.
          Aeciospores rather large (22–31μ), wall cinnamon-brown. 7. *G. exiguum.*
          Aeciospores rather small (17–23μ), wall dingy yellow. 8. *G. Photiniae.*
        Peridial cells rugose.
          Inner and side walls rather sparsely and coarsely rugose.
            Inner and side walls rather thick (7–9μ), aeciospore wall 1.5–2μ thick. 9. *G. Amelanchieris.*
            Inner and side walls thick (8–12μ), aeciospore wall 2–2.5μ thick. 10. *G. cornutum.*
          Inner and side walls densely and rather finely rugose (5–8μ thick).
            Aeciospore wall dark cinnamon-brown, 1.5–2μ thick. 11. *G. Torminali-juniperinum.*
            Aeciospore wall light cinnamon-brown, 2–2.5μ thick. 12. *G. Davisii.*
        Peridial cells verruculose. 36. *G. Nelsoni.*

Peridium dehiscent with longitudinal slits along the sides, tardily or not at all dehiscent at apex.
Peridial cells subspinulose. 16. G. *trachysorum.*
Peridial cells verrucose.
Aeciospores rather small (18–24μ), wall thin (1–1.5μ). 17. G. *solenoides.*
Aeciospores rather large (20–32μ), wall thick (3–4μ). 37. G. *corniculaus.*
Peridial cells verrucose-rugose 14. G. *juvenescens.*
Peridial cells rugose. 18. G. *tubulatum.*
Peridial cells smooth. 19. G. *Botryapites.*

aa Peridium soon losing tubular form by becoming deeply lacerate or fimbriate.
b Peridium spreading or more or less erect after dehiscence.
Peridial cells rough.
Peridial cells lanceolate in face view (not often seen in side view).
Aeciospores medium-sized (17–28μ).
Aeciospore wall cinnamon-brown, very thick (3–4μ). 20. G. *Nidus-avis.*
Aeciospore wall pale cinnamon-brown, moderately thick (2–2.5μ). 21. G. *exterum.*
Aeciospores large (25–33μ), wall light chestnut-brown. 14. G. *Cunninghamianum.*
Peridial cells rhomboid in side view (not often seen in face view).
Peridial cells verrucose, aeciospores large (21–39μ), wall yellowish. 22. G. *germinale.*
Peridial cells rugose.
Aeciospores small (18–23μ), wall cinnamon-brown. 26. G. *japonicum.*
Aeciospores very large (28–45μ), wall chestnut-brown. 23. G. *juniperinum.*
Peridial cells linear-rhomboid or linear in side view.
Peridial cells verrucose.
Aeciospores small (18–22μ), wall rather thick (1.5–2.5μ). 29. G. *transformans.*
Aeciospores rather large (21–30μ), wall thick (2.5–3.5μ). 30. G. *clavariaeforme.*
Peridial cells verruculose. 31. G. *Yamadae.*
Peridial cells rugose.
Inner and side walls moderately rugose, rather thick (3–6μ).
Aeciospores moderately large (18–30μ), wall rather thick (2.5–3μ). 33. G. *Betheli.*
Aeciospores rather small (15–25μ), wall rather thin (1.5–2μ). 34. G. *globosum.*
Inner and side walls strongly rugose, moderately thick (5–7μ). 28. G. *Mespili.*
Peridial cells smooth. 35. G. *hyalinum.*

bb Peridium strongly revolute after dehiscence.
Peridial cells somewhat curved when wet, side walls closely rugose nearly to outer side. 38. *G. floriforme.*
Peridial cells strongly curved when wet, side walls rather sparsely rugose on inner half. 39. *G. Juniperi-virginianae.*
aaa Peridium balaniform, rupturing along the sides, peridial cells rugose. 27. *G. Sabinae.*
Autoecious, aecia elongated, appearing on galls like the telia, peridium soon lacerate, peridial cells rugose. 40. *G. bermudianum.*

B. TELIA EXCLUSIVELY CONSIDERED

Telia appearing on the leaves or young branches, not causing material hypertrophy (except in Nos. 9 and 11).
Telia not causing fasciation of the branches.
Telia pulvinate, low.
Teliospores 2–5-celled, pedicels terete. 1. *G. Blasdaleanum.*
Teliospores 2-celled.
Pedicels of teliospores terete. 3. *G. fraternum.*
Pedicels of teliospores carotiform. 4. *G. inconspicuum.*
Telia musciform. 6. *G. multiporum.*
Telia tongue-shaped. 7. *G. exiguum.*
Telia applanate (causing slight fusiform swellings). 9. *G. Amelanchieris.*
Telia hemispheric.
Teliospores with hyaline papillae over the germ-pores.
Teliospores rather small (31–42μ long), papillae often not conspicuous (2–5μ). 10. *G. cornutum.*
[Telia also on fusiform swellings of branches—see below.]
Teliospores medium-sized (35–49μ long), papillae noticeable (3–6μ). 11. *G. Torminali-juniperinum.*
Teliospores rather large (40–55μ long), papillae large (4–7μ). 12. *G. Davisii.*
Teliospores without hyaline papillae over the germ-pores, large (56–72μ long). 13. *G. Cunninghamianum.*
Telia causing fasciation of the branches, or witches' brooms.
Telia cinnamon-brown, teliospores ellipsoid, medium-sized (39–52μ long). 14. *G. juvenescens.*
Telia reddish-brown, teliospores narrowly ellipsoid, large (55–74μ long). 15. *G. Kernianum.*
Telia appearing on twigs or branches, causing more or less hypertrophy.
Enlargements abruptly fusiform, short, telia wedge-shaped. 16. *G. trachysorum.*
Enlargements irregularly fusiform and knot-like, telia pulvinate. 17. *G. solenoides.*
Enlargements gradually fusiform, long.
Telia hemispheric, usually small and definite.
Teliospores 2–4-celled, pedicels terete. 19. *G. Botryapites.*

Teliospores 2-celled.
Pedicels of teliospores terete. 20. *G. Nidus-avis.*
Pedicels of teliospores carotiform. 22. *G. germinale.*
Telia applanate or pulvinate, usually large and somewhat indefinite
Teliospores with hyaline papillae over the germ-pores. 10. *G. cornutum.*
Teliospores without hyaline papillae over the germ-pores.
Teliospores rather small (32–42μ long). 21. *G. exterum.*
Teliospores rather large (42–61μ long). 23. *G. juniperinum.*
Telia cristiform, irregularly crenate above. 24. *G. gracilens.*
Telia wedge-shaped, often irregular and lacunose.
Teliospores medium-sized (42–55μ long). 25. *G. effusum.*
Teliospores rather large (57–66μ long). 26. *G. japonicum.*
Telia conic or often laterally compressed.
Teliospores slightly constricted, usually narrowed both above and below. 27. *G. Sabinae.*
Teliospores mostly not constricted, usually rounded at apex. 28. *G. Mespili.*
Telia terete or cylindric.
Telia stout, teliospores 2-celled. 30. *G. clavariaeforme.*
Telia slender, teliospores 2–5-celled. 32. *G. Ellisii.*
Telia often causing fasciation of the branches or witches' brooms.
Telia hemispheric, spores 2-celled. 20. *G. Nidus-avis.*
Telia terete, spores 2–5-celled. 32. *G. Ellisii.*
Telia appearing on galls or gall-like excrescences.
Galls very irregular, usually elongated and knot-like, often in succession along a branch. 33. *G. Betheli.*
Galls globoid or reniform.
Telia laterally compressed.
Telia thick, wedge-shaped, chestnut-brown. 34. *G. globosum.*
Telia thin, irregularly flattened, light chestnut-brown. 36. *G. Nelsoni.*
Telia terete.
Telia somewhat conic, chestnut-brown.
Teliospores with slight hyaline thickenings over the germ-pores. 37. *G. corniculans.*
Teliospores without hyaline thickenings over the germ-pores. 38. *G. floriforme.*
Telia cylindric or cylindric-acuminate, golden-brown. 39. *G. Juniperi-virginianae.*
Telia pulvinate, low, inconspicuous. 40. *G. bermudianum.*

8. Host Keys

A. Hosts harboring aecial phase

a. Order Rosales, family Malaceae (Pomaceae)

CRATAEGUS:

Aecia short, cupulate, peridium lacerate or erose. 1. *G. Blasdaleanum.*

Aecia elongated, tubular at first, in some species altered by dehiscence.
  Peridium retaining tubular or cornute form.
    Peridium finally dehiscent at apex, slightly or not at all lacerate along sides. 7. *G. exiguum.*
    Peridium dehiscent with longitudinal slits along the sides.
      Peridial cells subspinulose. 16. *G. trachysorum.*
      Peridial cells rugose. 18. *G. tubulatum.*
  Peridium soon losing tubular form by becoming deeply lacerate or fimbriate.
    Peridium spreading or more or less erect after dehiscence.
      Peridial cells rough.
        Peridial cells verrucose.
          Aeciospore wall pale yellow, coarsely verrucose. 22. *G. germinale.*
          Aeciospore wall cinnamon-brown, moderately verrucose. 30. *G. clavariaeforme.*
        Peridial cells rugose.
          Inner and side walls moderately rugose, rather thick (3–6μ).
            Aeciospores moderately large (18–30μ), wall rather thick (2.5–3μ). 33. *G. Betheli.*
            Aeciospores rather small (15–25μ), wall rather thin (1.5–2μ). 34. *G. globosum.*
          Inner and side walls strongly rugose, moderately thick (5–7μ). 28. *G. Mespili.*
      Peridial cells smooth. 35. *G. hyalinum.*
    Peridium strongly revolute. 38. *G. floriforme.*

AMELANCHIER:

Aecia short, cupulate, peridium lacerate or erose. 1. *G. Blasdaleanum.*

Aecia elongated, tubular at first, in some species altered by dehiscence.
  Peridium retaining tubular or cornute form.
    Peridium finally dehiscent at apex, slightly or not at all lacerate along sides.
      Peridial cells verrucose.
        Side walls of peridial cells verrucose only on inner third. 4. *G. inconspicuum.*
        Side walls of peridial cells verrucose over entire surface. 5. *G. Harknessianum.*

Peridial cells rugose. 9. G. *Amelanchieris.*

Peridial cells verruculose. 36. G. *Nelsoni.*

Peridium dehiscent with longitudinal slits along the sides.

Peridial cells verrucose. 37. G. *corniculans.*

Peridial cells verrucose-rugose. 14. G. *juvenescens.*

Peridial cells smooth. 19. G. *Botryapites.*

Peridium soon losing tubular form by becoming lacerate and more or less spreading.

Peridial cells rugose. 20. G. *Nidus-avis.*

Peridial cells verrucose.

Aeciospore wall pale yellow, coarsely verrucose. 22. G. *germinale.*

Aeciospore wall cinnamon-brown, moderately verrucose. 30. G. *clavariaeforme.*

Pyrus:

Aecia elongated, tubular at first, soon altered by becoming deeply lacerate or fimbriate.

Peridium soon losing tubular form by becoming deeply lacerate or fimbriate.

Peridial cells lanceolate in face view (not often seen in side view), aeciospores large (25–33μ). 13. G. *Cunninghamianum.*

Peridial cells rhomboid in side view (not often seen in face view), aeciospores small (18–23μ). 26. G. *japonicum.*

Peridial cells linear-rhomboid in side view.

Peridial cells verrucose. 30. G. *clavariaeforme.*

Peridial cells rugose.

Inner and side walls moderately rugose, moderately thin (3–5μ). 34. G. *globosum.*

Inner and side walls strongly rugose, rather thick (5–7μ). 28. G. *Mespili.*

Peridium retaining tubular form, peridial cells verruculose. 36. G. *Nelsoni.*

Aecia elongated, balaniform, rupturing along the sides, apex remaining bluntly conic. 27. G. *Sabinae.*

Malus:

Aecia short, cupulate, peridium lacerate or erose. 2. G. *Sorbi.*

Aecia elongated, tubular at first, in some species becoming altered by dehiscence.

Peridium spreading or more or less erect after dehiscence.

Peridial cells verruculose. 31. G. *Yamadae.*

Peridial cells verrucose. 22. G. *germinale.*

Peridial cells rugose.

Aeciospores rather small (15–25μ), wall rather thin (1.5–2μ). 34. G. *globosum.*

Aeciospores very large (28–45μ), wall very thick (3–5μ). 23. G. *juniperinum.*

Peridium strongly revolute, peridial cells strongly curved when wet. 39. G. *Juniperi-virginianae.*

SORBUS:

Aecia short, cupulate, peridium lacerate or erose. 2. *G. Sorbi.*

Aecia elongated, tubular at first, in some species becoming altered by dehiscence.

Peridium retaining tubular or cornute form, unaltered by dehiscence.

Peridial cells rugose.

Inner and side walls densely rugose, moderately thick (6–7μ). 11. *G. Torminali-juniperinum.*

Inner and side walls moderately rugose, thick (8–12μ). 10. *G. cornutum.*

Peridial cells verrucose. 17. *G. solenoides.*

Peridium losing tubular form by dehiscence, spreading or erect.

Aeciospores medium small (15–25μ), wall rather thin (1.5–2μ). 34. *G. globosum.*

Aeciospores very large (28–45μ), wall very thick (3–5μ). 23. *G. juniperinum.*

ARONIA:

Aecia elongated, tubular at first, in some species becoming altered by dehiscence.

Peridium retaining tubular or cornute form. 12. *G. Davisii.*

Peridium spreading or more or less erect after dehiscence.

Peridial cells rhomboid in side view (45–95μ long), aeciospore wall coarsely verrucose. 22. *G. germinale.*

Peridial cells linear-rhomboid in side view (80–130μ long), aeciospore wall moderately verrucose. 30. *G. clavariaeforme.*

Peridial cells linear in side view (150–300μ long), aeciospore wall, finely verrucose. 29. *G. transformans.*

CYDONIA:

Aecia elongated, tubular at first, becoming altered by dehiscence.

Peridial cells verrucose.

Aeciospore wall pale yellow, coarsely verrucose. 22. *G. germinale.*

Aeciospore wall cinnamon-brown, moderately verrucose. 30. *G. clavariaeforme.*

Peridial cells verruculose. 36. *G. Nelsoni.*

Peridial cells rugose.

Inner and side walls strongly rugose with ridges of varying length. 28. *G. Mespili.*

Inner and side walls rugose with long narrow ridges interspersed with roundish papillae. 20. *G. Nidus-avis.*

COTONEASTER:

Aecia elongated, tubular at first, becoming altered by dehiscence.

Peridial cells verrucose. 30. *G. clavariaeforme.*

Peridial cells rugose. 28. *G. Mespili.*

PERAPHYLLUM:

Aecia elongated, retaining tubular form, peridial cells verruculose.
36. *G. Nelsoni.*

MESPILUS:

Aecia elongated, tubular at first, becoming altered by dehiscence, peridial cells rugose. 28. *G. Mespili.*

POURTHIAEA:

Aecia short, cupulate, peridium lacerate or erose.
(?) 1. *G. Blasdaleanum.*

Aecia elongated, retaining tubular form after dehiscence, peridial cells subspinulose. 8. *G. Photiniae.*

b. Order Rosales, family Rosaceae

PORTERANTHUS:

Aecia elongated, altered by dehiscence, becoming lacerate almost to base, peridial cells rugose. 21. *G. exterum.*

c. Order Rosales, family Hydrangiaceae

FENDLERA:

PHILADELPHUS:

Aecia elongated, remaining tubular after dehiscence, peridial cells verrucose over entire surface. 24. *G. gracilens.*

d. Order Pinales, family Juniperaceae

JUNIPERUS:

Aecia elongated, appearing on galls like the telia, peridium soon lacerate, peridial cells rugose. 40. *G. bermudianum.*

B. HOSTS HARBORING TELIAL PHASE, ORDER PINALES, FAMILY JUNIPERACEAE

JUNIPERUS:

§ SABINA (genus SABINA).

Telia appearing on the leaves or young branches, not causing material hypertrophy.

Telia not causing fasciation of the branches.

Telia pulvinate, reddish-brown. 4. *G. inconspicuum.*

Telia musciform, chestnut-brown. 6. *G. multiporum.*

Telia tongue-shaped, chestnut-brown. 7. *G. exiguum.*

Telia causing fasciation of the branches, or witches' brooms.

Telia cinnamon-brown, teliospores ellipsoid, medium (39–52μ long).
14. *G. juvenescens.*

Telia reddish-brown, teliospores narrowly-ellipsoid, large (55–74μ).
15. *G. Kernianum.*

Telia appearing on twigs or branches, causing more or less hypertrophy.

Enlargements abruptly fusiform, short, telia wedge-shaped.
16. *G. trachysorum.*

Enlargements gradually fusiform, long.

Telia hemispheric.

Pedicels of teliospores terete. 20. *G. Nidus-avis.*
Pedicels of teliospores carotiform. 22. *G. germinale.*
Telia applanate or pulvinate. 21. *G. exterum.*
Telia cristiform. 24. *G. gracilens.*
Telia wedge-shaped, often irregular and lacunose.
Teliospores medium-sized (42–55µ long). 25. *G. effusum.*
Teliospores rather large (57–66µ long). 26. *G. japonicum.*
Telia conic or often compressed laterally.
Teliospores slightly constricted, usually narrowed both above and below. 27. *G. Sabinae.*
Teliospores mostly not constricted, usually rounded at apex. 28. *G. Mespili.*
Telia often causing fasciation of the branches, or witches' brooms. 20. *G. Nidus-avis.*
Telia appearing on galls or gall-like excrescences.
Galls very irregular, usually elongated and knot-like, often in succession along a branch. 33. *G. Betheli.*
Galls globoid or reniform, solitary.
Telia laterally compressed.
Telia thick, wedge-shaped, chestnut-brown. 34. *G. globosum.*
Telia thin, irregularly flattened, light chestnut-brown. 36. *G. Nelsoni.*
Telia terete.
Telia somewhat conic, chestnut-brown.
Teliospore wall with slight hyaline thickenings over the germ-pores. 37. *G. corniculans.*
Teliospore wall uniform, without hyaline thickenings. 38. *G. floriforme.*
Telia cylindric or cylindric-acuminate, golden-brown. 39. *G. Juniperi-virginianae.*
Telia pulvinate, low, inconspicuous. 40. *G. bermudianum.*

JUNIPERUS:
§ OXYCEDRUS (true JUNIPERUS).
Telia appearing on the leaves or young branches, with little or no hypertrophy.
Telia applanate, teliospores without hyaline papillae over the germ-pores. 9. *G. Amelanchieris.*
Telia hemispheric, teliospores with hyaline papillae over the germ-pores.
Teliospores rather small (31–42µ long), papillae often not conspicuous (2–5µ). 10. *G. cornutum.*
Teliospores medium-sized (35–49µ long), papillae noticeable (3–6µ). 11. *G. Torminali-juniperinum.*
Teliospores rather large (40–55µ long), papillae large (4–7µ). 12. *G. Davisii.*

Telia appearing on twigs or branches, causing more or less hypertrophy.
Telia hemispheric, usually small and definite.
22. *G. germinale.*
Telia applanate or pulvinate, usually large and somewhat indefinite.
Teliospores with hyaline papillae over the germ pores.
10. *G. cornutum.*
Teliospores without hyaline papillae over the germ pores.
23. *G. juniperinum.*
Telia terete or cylindric. 30. *G. clavariaeforme.*

CHAMAECYPARIS:
Telia appearing on the leaves, not causing hypertrophy, teliospores 2-celled.
3. *G. fraternum.*
Telia appearing on the twigs or branches causing more or less hypertrophy.
Enlargements gradually fusiform, surface rather regular.
Telia hemispheric, teliospores 2–4-celled.
19. *G. Botryapites.*
Telia terete, slender, teliospores 2–5-celled.
32. *G. Ellisii.*
Enlargements irregular, knotty, surface rough, teliospores 2–3-celled.
17. *G. solenoides.*
Telia often causing fasciation of the branches, or witches' brooms.
32. *G. Ellisii.*

CUPRESSUS:
Telia appearing on the smaller branches, with little or no hypertrophy, telia hemispheric, teliospores 2-celled. 13. *G. Cunninghamianum.*

HEYDERIA:
Telia appearing on the leaves, not causing hypertrophy, teliospores 2–5-celled. 1. *G. Blasdaleanum.*

9. Specific Descriptions

1. **Gymnosporangium Blasdaleanum** (Diet. & Holw.)

Aecidium Blasdaleanum Diet. & Holw. Erythea **3**: 77. 1895.
Phragmidium Libocedri P. Henn. Hedw. **37**: 271. 1898.
?*Aecidium Pourthiaeae* Sydow, Mem. Herb. Boiss. **4**: 3. 1900.
Gymnosporangium aurantiacum Sydow, Ann. Myc. **2**: 28. 1904.
Gymnosporangium Libocedri Kern, Bull. Torrey Club **35**: 509. 1908.

Aecia hypophyllous and fruiticolous, in crowded groups 1–5 mm. across, cupulate, low, 0.2–0.3 mm. in diam.; peridium delicate, margin lacerate, spreading or somewhat recurved; peridial cells rhomboid in side view, 18–23μ long, outer wall 3–4μ thick, transversely striate, smooth, inner and side walls about half as thick, verrucose; aeciospores globoid, 12–20×14–23μ, wall pale yellow, rather thin, 1–1.5μ, finely verrucose.

Telia foliicolous, not causing noticeable distortions, scattered, roundish-oval, about 0.8–1.5 mm. across, pulvinate, reddish-brown,

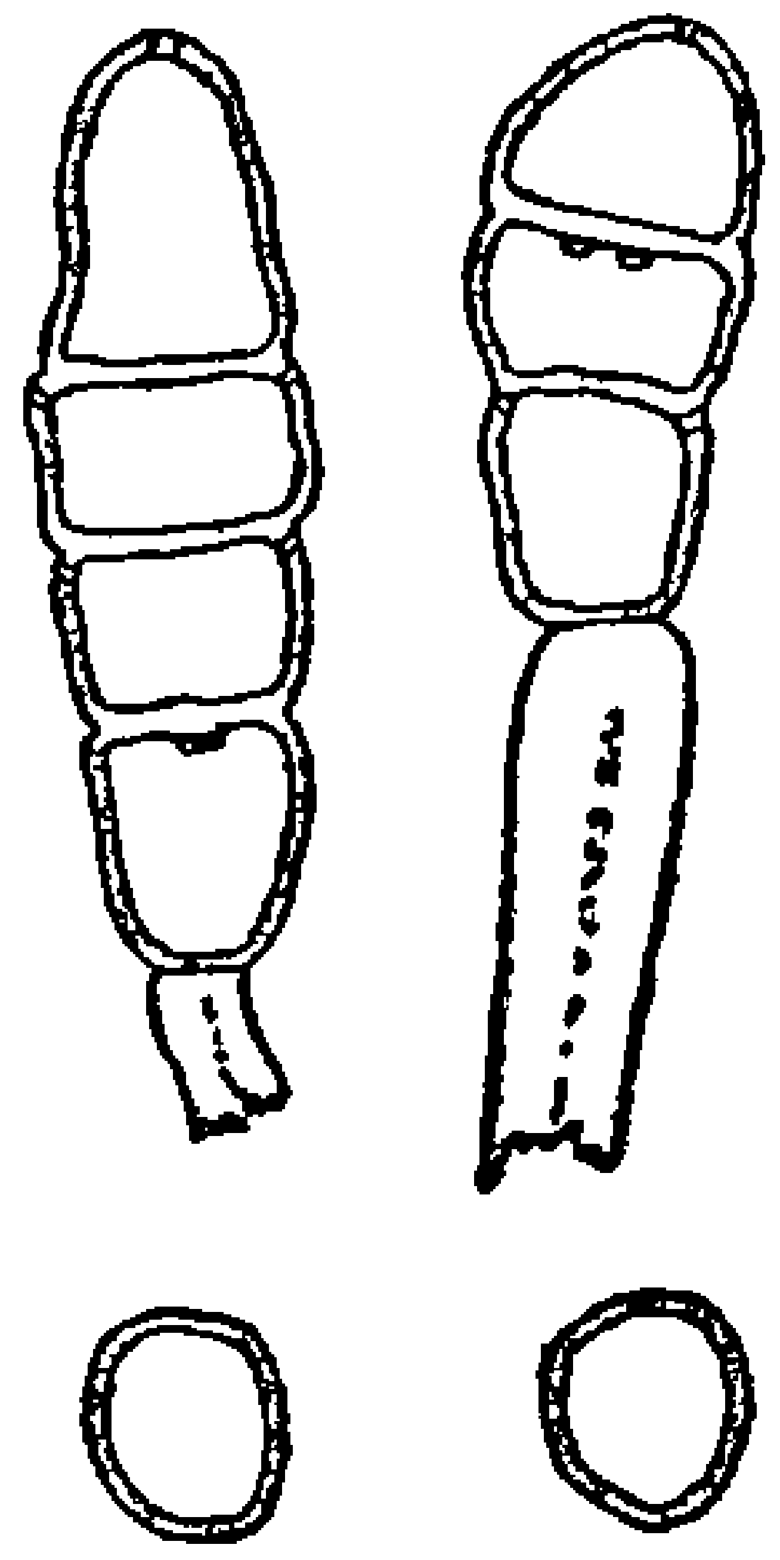

FIG. 2.* *G. Blasdaleanum.*

ruptured epidermis not noticeable; teliospores 2–5-celled, linear-oblong, 19–30 × 35–87 μ, slightly constricted at the septa, wall pale brown, thin, 1μ; pedicels cylindric, often large, 7–25μ in diam.; pores 2, except in upper cell, apical.

HOST PLANTS:

For the aecia: *Amelanchier alnifolia* Nutt., *A. florida* Lindl., *A. pallida* Greene, *Crataegus Douglasii* Lindl. (*C. brevispina* Dougl.), *C. rivularis* Nutt., ?*Pourthiaea villosa* (Thunb.) Dec. (*Photinia villosa* DC.).

For the telia: *Heyderia decurrens* (Torr.) K. Koch. (*Libocedrus decurrens* Torr.).

TYPE LOCALITY: Shasta Springs, Siskiyou Co., Calif., on *Crataegus rivularis.*

DISTRIBUTION: Pacific slope of the United States from Oregon southward into northern California; possibly also in Japan (*Aecidium Pourthiaeae* Sydow).

EXSICCATI: Sydow, Ured. *1149, 1786;* Ellis & Ev., N. Am. Fungi *3248.*

2. **Gymnosporangium Sorbi** (Arth.)

?*Uredo nootkatensis* Trel. Harriman Alaska Exped. **5**: 36. 1904.
Aecidium Sorbi Arth. Bull. Torrey Club **33**: 521. 1906.

Aecia hypophyllous, in small groups of 4–7 on discolored thickened spots, or often more numerous on larger swellings on the veins or rachis, cupulate, 0.2–0.4 mm. high, 0.2–0.3 mm. in diam.; peridium colorless, margin nearly erect, erose; peridial cells rhomboid in side view, 30–45μ long, outer wall thick, 10–13μ, transversely striate, smooth, inner and side walls thinner, 3–5μ, verrucose; aeciospores broadly ellipsoid, 23–27×27–39μ, wall pale yellow, thick, 3–4μ, minutely verrucose.

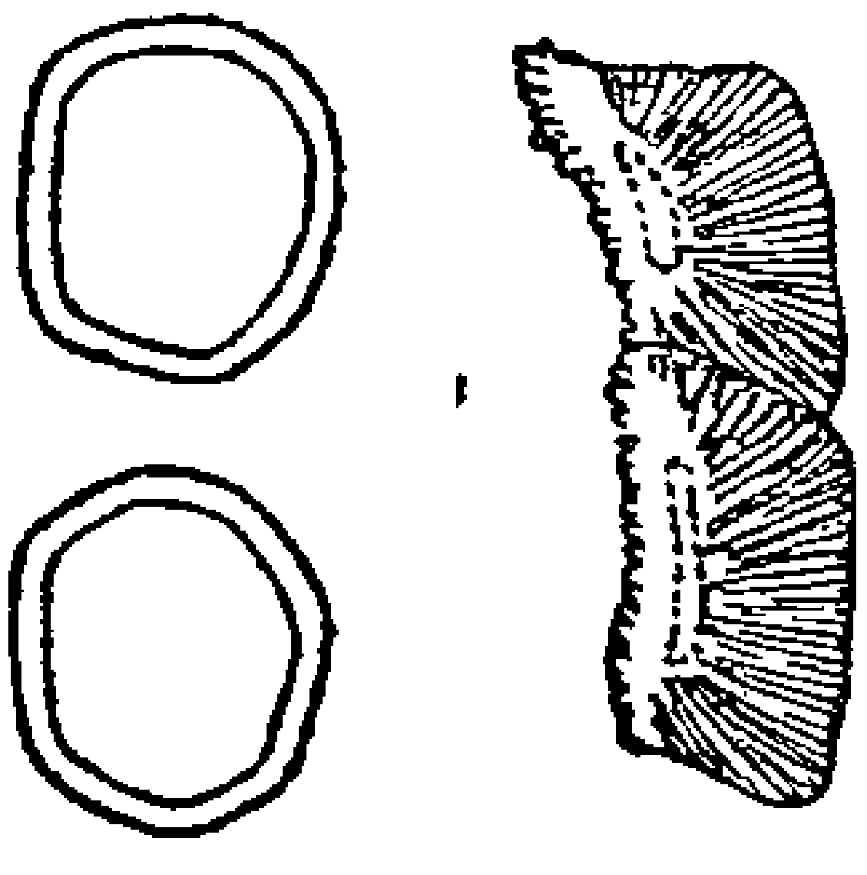

FIG. 3. *G. Sorbi.*

Telia unknown.

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*This and the following text-figures are all made to the same scale. Teliospores and side views of peridial cells have been chiefly employed for these illustrations. A few drawings of aeciospores are included. For further details see Explanation of Illustrations (text-figures), p. 480.

HOST PLANTS:

For the aecia: *Malus rivularis* (Doug.) Roem., *Sorbus occidentalis* (Wats.) Greene, *S. scopulina* Greene.

For the telia: unknown, possibly *Chamaecyparis nootkatensis.*

TYPE LOCALITY: Hodag Lake, Vancouver Island, B. C., on *Sorbus occidentalis.*

DISTRIBUTION: Along the Pacific coast of the United States from Alaska southward into Washington.

3. **Gymnosporangium fraternum** sp. nov.

Aecia unknown.

Telia foliicolous, solitary, scattered, oval, 0.8–2 mm. across, pulvinate, chestnut-brown, ruptured epidermis noticeable; teliospores 2-celled, ellipsoid, 16–19× 39–48μ, rounded above, narrowed below, slightly constricted at the septum, wall cinnamon-brown, medium, 1.5–2.5μ, thicker above, 3–5μ; pedicels cylindric, 5–6μ in diam.; pores 2 in each cell, near the septum.

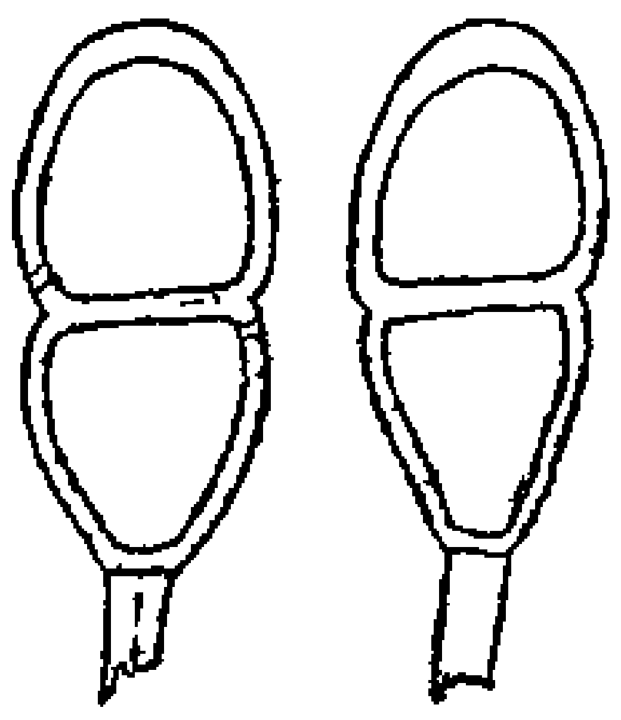

FIG. 4. *G. fraternum.*

HOST PLANTS:

For the aecia: unknown.

For the telia: *Chamaecyparis thyoides* (L.) B.S.P. (*Cupressus thyoides* L., *Chamaecyparis sphaeroidea* Spach.)

Type collected at Newfield, N. J., on *Chamaecyparis thyoides*, April, 1880, *J. B. Ellis* (Ellis & Ev. N. Am. Fungi *1479*—host erroneously determined as *Thuja occidentalis*).

DISTRIBUTION: Small area along the Atlantic coast from Massachusetts to New Jersey.

EXSICCATI: Seym. & Earle, Econ. Fungi *244;* Ellis, N. Am. Fungi *1479;* Roum. Fungi Sel. *4886.*

The form which is here recognized as a species was given subspecific rank in 1885 by Farlow in Ellis, N. Am. Fungi *1479*, under the name *G. biseptatum foliicolum*, without any accompanying description. The writer has made several unsuccessful attempts to cultivate this form and culture evidence is therefore lacking to support its standing as a distinct species. Its habit and morphological characters are however so distinct from *G. Botryapites* (*biseptatum*), the only species with which it appears to be at all allied, that the writer feels justified in recognizing it as a good species.

4. GYMNOSPORANGIUM INCONSPICUUM Kern, Bull. Torrey Club **34**: 461. 1907

Roestelia Harknessianoides Kern, Bull. Torrey Club **34**: 463. 1907.

Aecia chiefly fruiticolous, scattered irregularly or crowded, cylindric, 0.5–0.8 mm. in diameter by 2–4 mm. high; peridium rather tough, rupturing at apex, not becoming lacerate along the sides, remaining tubular; peridial cells seen in both face and side views, polygonal-oblong in face view, 25–35×65–100μ, rhomboid in side view, thick, 45–55μ, outer wall moderately thick 5–8μ, smooth, inner wall very thick, 27–35μ, moderately and closely verrucose with slightly irregular papillae, side walls verrucose only on inner third similar to inner wall; aeciospores globoid, 23–27×25–31μ, wall pale yellow, 2–2.5μ thick, finely verrucose.

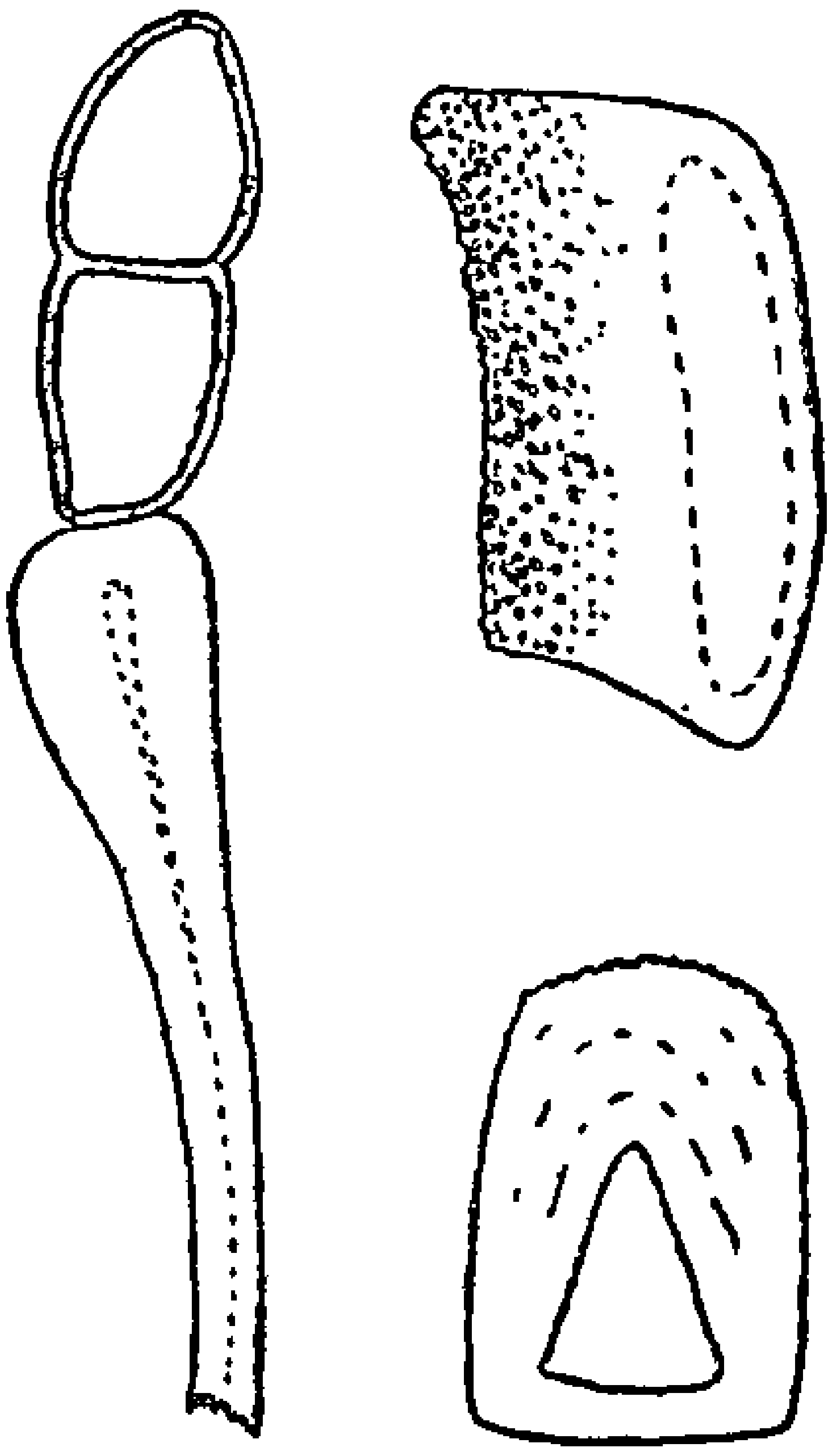

FIG. 5. *G. inconspicuum.*

Telia caulicolous, usually arising between the scale-like leaves on the green branches, usually causing a yellowing of the leaves, more rarely on the woody branches, scattered or aggregated and often confluent about the entire margins of several adjacent scale-like leaves, pulvinate, oblong, 0.4–1 mm. wide, 0.5–1 mm. high, reddish-brown; teliospores 2-celled, oblong-ellispoid, 25–29×55–80μ, often acutish at apex, obtuse below, not or only slightly constricted at the septum, wall thin, about 1μ, golden yellow; pedicel carotiform; swelling greatly next to the spore, 25–65μ; pores one in each cell, apical in the upper, near the pedicel in the lower.

HOST PLANTS:

For the aecia: *Amelanchier alnifolia* Nutt., *A. oreophila* A. Nels., *A. utahensis* Koehne.

For the telia: *Juniperus utahensis* (Engelm.) Lemm. (*Sabina utahensis* Rydb.).

TYPE LOCALITY: Glenwood Springs, Colorado, on *Sabina utahensis.*

DISTRIBUTION: In the mountains of western Colorado, Utah, and New Mexico.

ILLUSTRATIONS: Bot. Gaz. **49**: *pl. 22, f. 15;* Mycologia **3**: 158, *f. 1d.*

EXSICCATI: Ellis & Ev. Fungi Columb. *1293.*

5. **Gymnosporangium Harknessianum** (Ellis & Ev.)

Roestelia Harknessiana Ellis & Ev.; Kern, Bull. Torrey Club **34**: 462. 1907.

Aecia chiefly fruiticolous, evenly disposed, cylindric, 0.5–0.8 mm. in diameter, 4–7 mm. long; peridium tough, dehiscent at apex, not becoming lacerate along the sides, remaining tubular; peridial cells seen in both face and side views, polygonal-oblong in face view, 40–65 × 90–112µ, rhomboid in side view, 58–74µ thick, outer wall moderately thick, 4–6 µ, smooth, inner wall thick, 15–20µ, coarsely verrucose with roundish or slightly irregular papillae, side walls verrucose over the entire surface similar to the inner wall, papillae slightly less crowded toward outer wall; aeciospores globoid, 22–26 × 26–30µ, wall light cinnamon-brown, 2–2.5µ thick, finely verrucose.

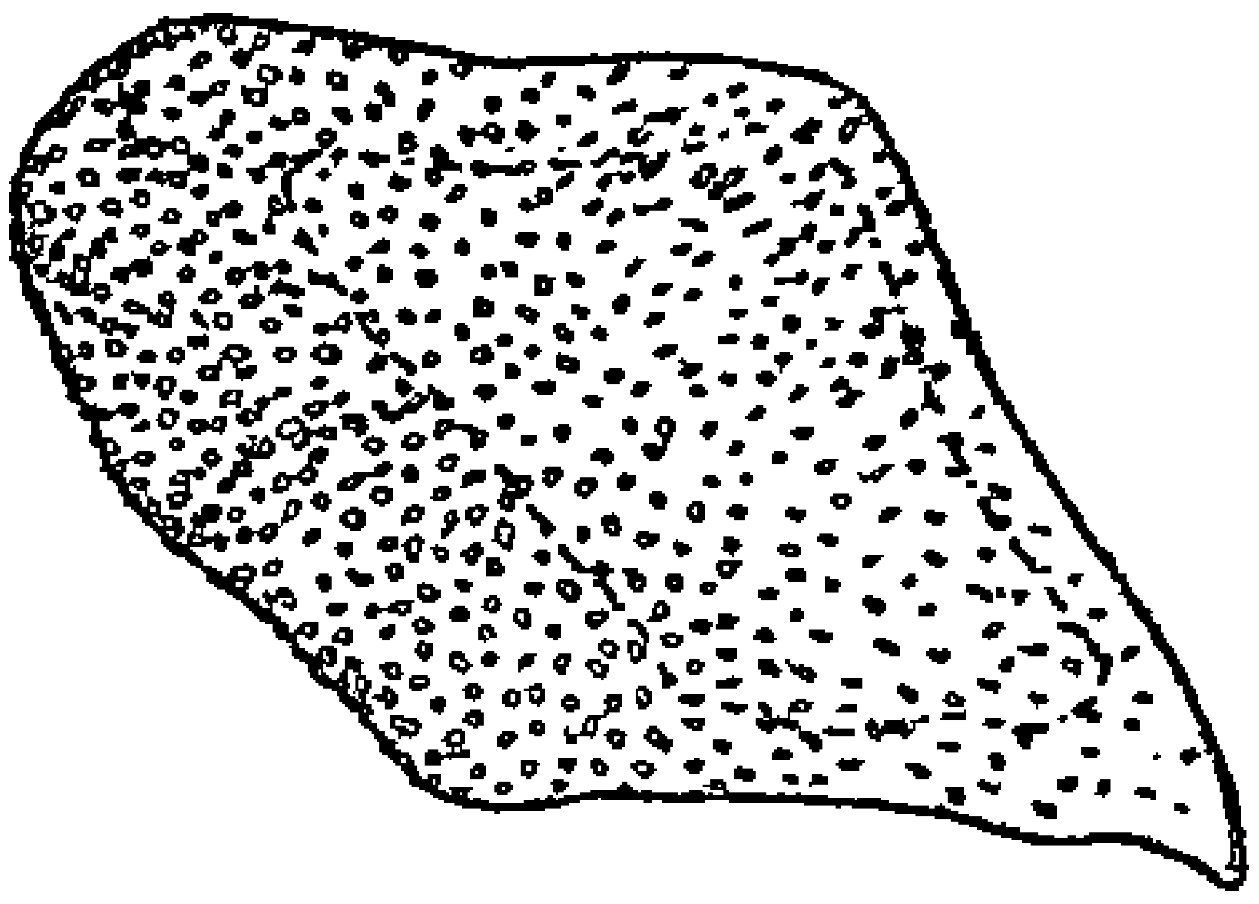

FIG. 6. *G. Harknessianum.*

Telia unknown.

HOST PLANTS:

For the aecia: *Amelanchier alnifolia* Nutt.

For the telia: unknown.

TYPE LOCALITY: Klamath River, California, on *Amelanchier alnifolia.*

DISTRIBUTION: Known only from type locality.

ILLUSTRATION: Bot. Gaz. **49**: *pl. 22, f. 16.*

EXSICCATI: Ellis & Ev. N. Am. Fungi *2714.*

6. GYMNOSPORANGIUM MULTIPORUM Kern, Mycologia **1**: 210. 1909

Aecia unknown.

Telia caulicolous, arising between the scale-like leaves on the green twigs, scattered or aggregated and confluent, musciform, 0.5–1 mm. across by 0.5–0.8 mm. high, light chestnut-brown; teliospores 2-celled, ellipsoid, 20–24×45–51µ, rounded both above and below, considerably constricted at the septum, wall light cinnamon-brown, 1.5–2.5µ thick; pedicel cylindric; pores 5–7 in each cell, large, scattered.

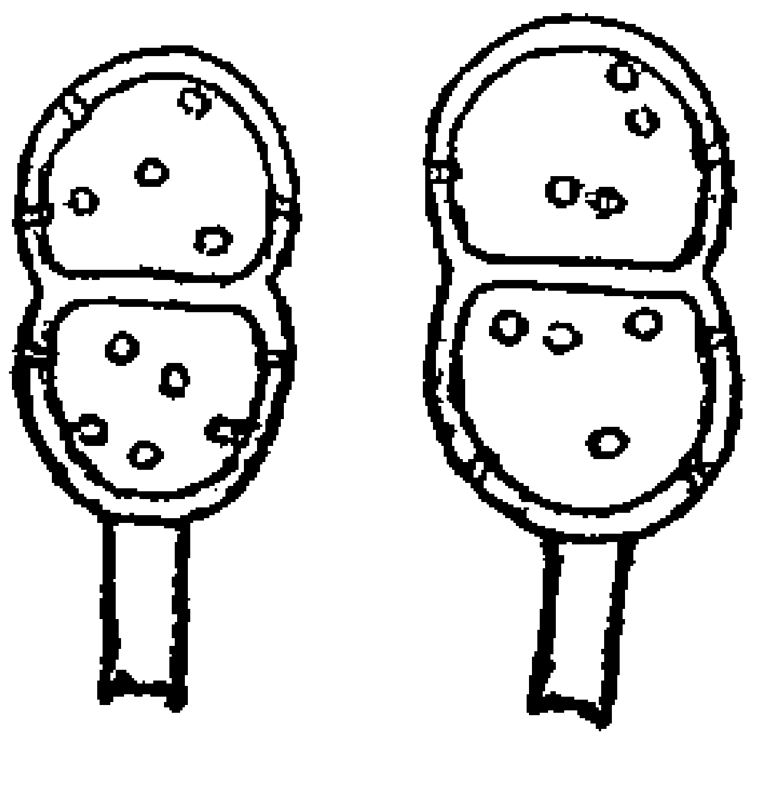

FIG. 7. *G. multiporum.*

HOST PLANTS:

For the aecia: unknown.

For the telia: *Juniperus monosperma* (Engelm.) Sarg. (*Sabina monosperma* Rydb.), *Juniperus utahensis* (Engelm.) Lemm. (*Sabina utahensis* Rydb.).

TYPE LOCALITY: Trinidad, Colorado, on *Sabina monosperma*.

DISTRIBUTION: Southern Colorado.

ILLUSTRATION: Mycologia **1**: 209, *f. 2;* **3**: 158, *f. 1b.*

7. GYMNOSPORANGIUM EXIGUUM Kern, Bull. Torrey Club **35**: 508. 1908

Aecia hypophyllous and fruiticolous, rather sparsely arranged in irregular groups, causing considerable hypertrophy of the veins, petioles, or fruits, cylindric, 2–3 mm. high by 0.3–0.4 mm. in diameter; peridium rupturing at apex, margin not splitting much, erect, peridial cells usually seen in face view, very broadly lanceolate, 29–40×70–90µ, oblong in side view, 25–30µ thick, outer wall thin, about 3µ, very closely spinulose, inner and side walls thick, 9–14µ, sculptured like the outer wall but with longer papillae (up to 6µ long); aeciospores globoid or broadly ellipsoid, 22–25×26–31µ, wall cinnamon-brown, 2–3µ thick, finely verrucose.

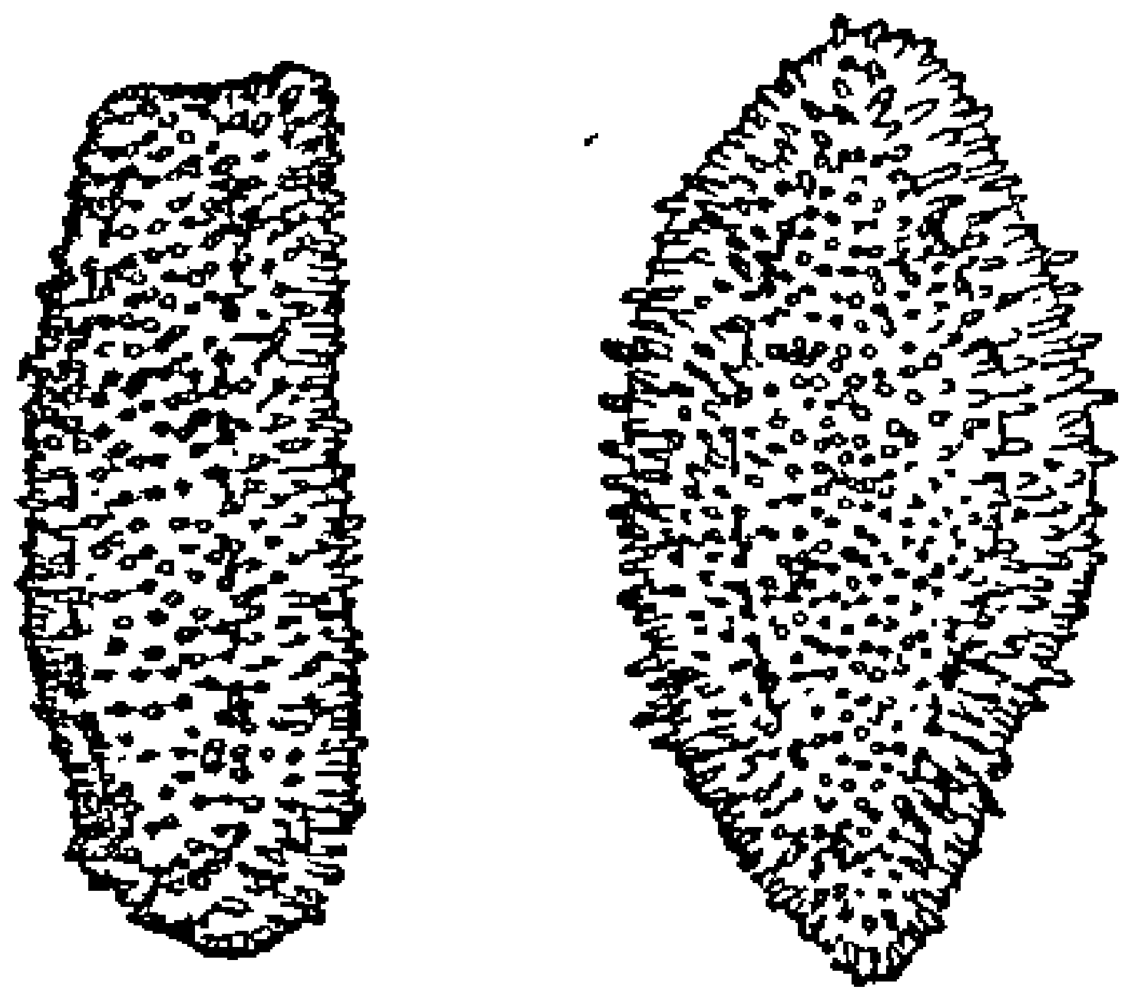

FIG. 8. *G. exiguum.*

Telia foliicolous, scattered, tongue-shaped or conic, small, 0.5–1 mm. thick by 1–1.5 mm. high, chestnut-brown; teliospores 2-celled, ellipsoid, 18–23×45–55µ, rounded or slightly narrowed both above and below, slightly or not constricted at the septum, wall pale cinnamon-brown, rather thin, about 1.5µ; pores 2 in each cell near the septum.

HOST PLANTS:

For the aecia: *Crataegus Tracyi* Ashe.

For the telia: *Juniperus mexicana* Spreng. (*Cupressus sabinioides* H.B.K., *J. sabinoides* Nees.), *J. pachyphlaea* Torr. (*Sabina pachyphlaea* Antoine), *J. virginiana* L. (*Sabina virginiana* Antoine).

TYPE LOCALITY: Fredericksburg, Texas, on *Sabina virginiana*.

DISTRIBUTION: Central and western Texas.

ILLUSTRATION: Bot. Gaz. **49**: *pl. 22, f. 17.*

EXSICCATI: Barth. N. Am. Ured. 7.

8. **Gymnosporangium Photiniae** (P. Henn.)

Roestelia Photiniae P. Henn. Hedwigia **33**: 231. 1894.

Aecia hypophyllous, gregarious, numerous, in crowded groups on thickened spots, cylindric, 0.2–0.4 mm. in diameter by 3–4 mm. high; peridium rupturing at apex, remaining tubular, becoming somewhat cancellate in upper part; peridial cells seen in both side and face views, oblong in side view, 23–29 × 61–93 µ, lanceolate in face view, 25–35µ broad, outer wall rather thin, 2–3µ, inner and side walls rather thick, 5–7µ, densely and rather sharply subspinulose; aeciospores broadly ellipsoid or globoid, 17–18 × 19–23 µ, wall dingy yellow, moderately thick, 2.5–3.5 µ, evenly and moderately verrucose.

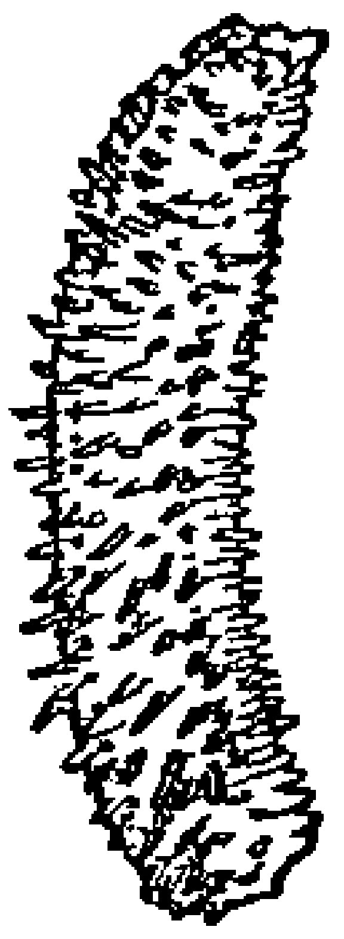

FIG. 9. *G. Photiniae.*

Telia unknown.

HOST PLANTS:

For the aecia: *Pourthiaea villosa* (Thunb.) Dec. (*Photinia villosa* Dec., *Photinia laevis* DC.).

For the telia: unknown.

TYPE LOCALITY: Yokohama, Japan, on *Photinia laevis.*

DISTRIBUTION: Japan.

9. GYMNOSPORANGIUM AMELANCHIERIS (DC.) Ed. Fisch. Zeits. f. Bot. **1**: 711. 1909

Aecidium Amelanchieris DC. Fl. Fr. **6**: 97. 1815.
Centridium mamillosum Chev. Fl. Env. Paris **1**: 383. 1826.
Centridium Amelanchieris Desm. Pl. Crypt. *1377.* 1845.
Roestelia Amelanchieris Roum. Fungi Gall. *2732.* 1884.

Aecia hypophyllous, in small groups, borne in gall-like, frustum-shaped protuberances which are often coalescent, cylindric, 0.3–0.5 mm. in diameter by 3–5 mm. high; peridium finally dehiscent at apex, becoming somewhat split along the sides; peridial cells usually seen in side view, rhomboid, 29–39 by 80–100µ, moderately rugose on inner and side walls, with ridge-like papillae of varying length, outer wall rather thin, 2–3µ, inner and side walls rather thick, 7–9µ; aeciospores broadly ellipsoid or globoid, 19–23×25–29µ, wall light chestnut-brown, 1.5–2µ thick, finely verrucose.

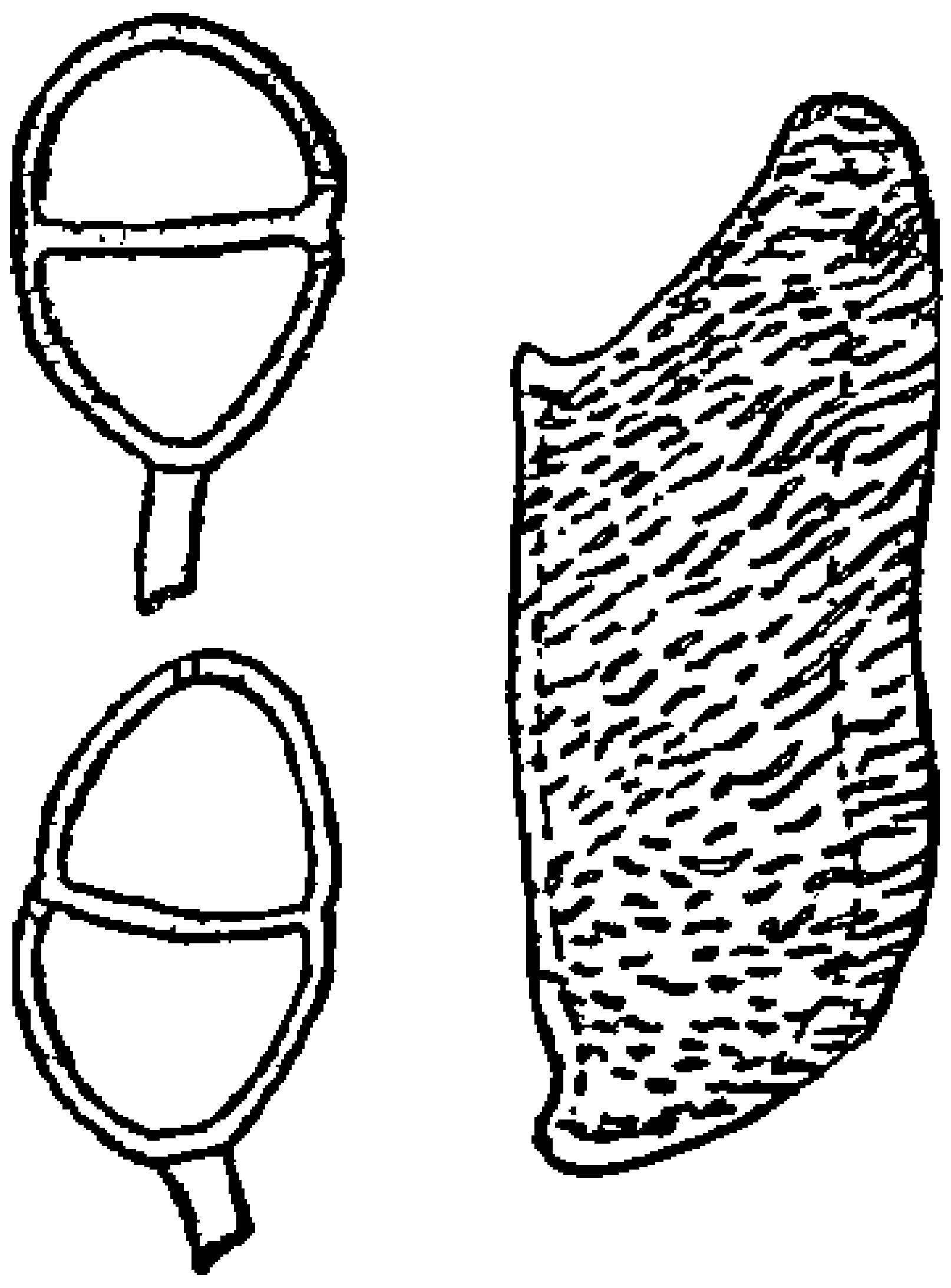

FIG. 10. *G. Amelanchieris.*

Telia chiefly caulicolous, appearing on slight fusiform swellings of the smaller branches, applanate, indefinite, varying in size, 3–5 mm. across, chestnut-brown; teliospores 2-celled, very broadly ellipsoid, 23–39×45–56μ, usually rounded both above and below; slightly or not constricted at the septum, wall light chestnut-brown, 1.5–2μ thick, without hyaline thickenings over the germ-pores; pores 1 or 2 in each cell, apical or near the septum.

HOST PLANTS:

For the aecia: *Amelanchier ovalis* Medic. (*A. vulgaris* Moench., *Aronia rotundifolia* Pers.).

For the telia: *Juniperus communis* L. [*J. sibirica* Burgsd.].

TYPE LOCALITY: Jura, France, on *Amelanchier* [*vulgaris*].

DISTRIBUTION: Europe.

ILLUSTRATIONS: Zeits. f. Bot. **1**: *f. 7.*

EXSICCATI: Sydow, Ured. *2287;* Allesch. & Schn. Fungi Bav. *514;* Roum. Fungi Gall. *2732;* Desm. Pl. Crypt. Fr. *1377;* Briosi & Cavara, Funghi Paras. *162;* Sacc. Myc. Ven. *399;* Sacc. Myc. Ital. *1097, 1257;* Rab.-Paz. Fungi Eur. *4112.*

10. GYMNOSPORANGIUM CORNUTUM (Pers.) Arth. Mycologia **1**: 240. 1909

Aecidium cornutum Pers. in J. F. Gmel. Syst. Nat. **2**: 1472. 1791.
Caeoma cornutum Schlecht. Fl. Berol. **2**: 111. 1824.
Caeoma cylindrites Link, in Willd. Sp. Pl. **6^2**: 64. 1825.
Gymnosporangium Juniperi Link, in Willd. Sp. Pl. **6^2**: 127. 1825.
Centridium Sorbi Chev. Fl. Env. Paris **1**: 383. 1826.
Gymnosporangium aurantiacum Chev. Fl. Env. Paris **1**: 424. 1826.
Roestelia cornutum Fries, Sum. Veg. Scand. **2**: 510. 1849.
Ceratitium cornutum Rabenh. Bot. Zeit. **9**: 452. 1851.
Podisoma juniperinum Oersted, Overs. Danske Vid. Selsk. Forh. **1866**: 191. 1866.

Aecia chiefly hypophyllous, in irregular or annular groups 3–10 mm. across, on thickened discolored areas, cylindric, somewhat attenuated above, acute at apex, 3–5 mm. high, 0.4–0.6 mm. in diameter; peridium rupturing rather tardily at apex, becoming somewhat but not deeply lacerate; peridial cells seen in both face and side views, broadly lanceolate in face view, 19–29×60–110μ, rhomboid in side view, 30–35μ thick, outer wall thin, 2μ, smooth, inner and side walls thick, 8–12μ, moderately rugose with short ridge-like papillae; aeciospores globoid, 18–25×21–29μ, wall light chestnut-brown, 2–2.5μ thick, rather finely verrucose.

Telia chiefly caulicolous, usually appearing on slight fusiform enlargements of the smaller woody branches, occasionally appearing on the leaves also, scattered, solitary or often aggregated and confluent, irregular, varying greatly in size, 1–3 mm. across, applanate and low or somewhat pulvinate, light chocolate-brown, teliospores 2-celled, broadly ellipsoid, 16–22×31–42μ, usually narrowed below, rounded or attenuated at the apex, sometimes enlarged near the septum in one or two places owing to the presence of hyaline papillae over the germ-pores, not or only rarely constricted at the septum, wall light cinnamon-brown, thin, about 1μ, papillae 2–5μ; pores 1–2 in each cell, apical or near the septum.

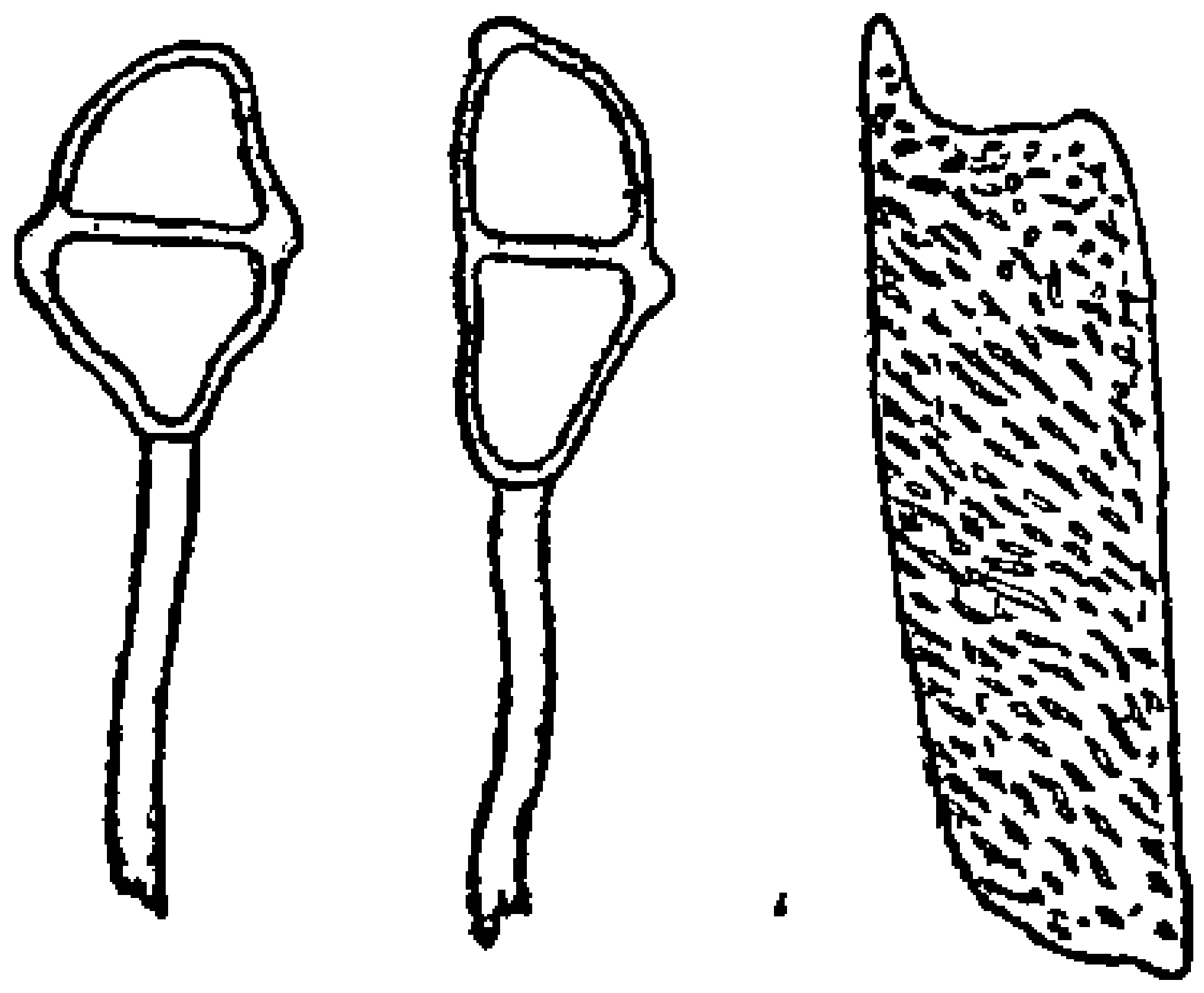

Fig. 11. *G. cornutum.*

Host plants:

For the aecia: *Sorbus americana* Marsh., *S. Aucuparia* L., *S. hybrida* L. (= *S. Aria* × *aucuparia*), *S. scopulina* Greene (*S. sambucifolia* A. Gray not C. &. S.).

For the telia: *Juniperus communis* L., *J. sibirica* Burgsd. (*J. nana* Willd.).

Type locality: Norway, on *Sorbus aucuparia.*

Distribution: Greenland south to New York and Wisconsin, and in the mountains of Wyoming and Colorado; and in Europe.

Illustrations: Pers. Obs. Myc. **2**: *pl. 4, f. 2, 3;* Overs. Danske Vid. Selsk. Forh. **1866**: *pl. 3–4;* E. & P. Nat. Pflanzenfam. **1**^{1**}: *f. 33, A, B;* Grev. Crypt. Fl. **3**: *pl. 180;* Bot. Gaz. **49**: *pl. 22, f. 14.*

Exsiccati: Ellis, N. Am. Fungi *1089;* Seym. & Earle, Econ. Fungi *248x;* Thüm. Myc. Univ. *1325;* Thüm. Fungi Austr. *954;* Sydow, Ured. *242, 840;* West. & Wall, Herb. Crypt. *742;* Sacc. Myc. Ven. *400;* Sacc. Myc. Ital. *45;* Linhart, Fungi Hung. *39, 238;* Sydow. Myc. Mar. *140, 428;* Krieger, Fungi Sax. *319;* Briosi & Cavara, Funghi Paras. *62;* Roum. Fungi Gall. *52;* Cooke, Fungi Brit. *1;* Rab. Fungi Eur. *2196;* Schm. & Kunze, Deutsch. Schwämne *110.*

11. Gymnosporangium Torminali-juniperinum Ed. Fisch.
Zeits. f. Bot. **2**: 759. 1910

Aecia hypophyllous, in small groups or sometimes solitary, on hypertrophied discolored spots, cylindric, 0.3–0.4 mm. in diameter by 2–3 mm. or more high; peridium finally dehiscent at apex, becoming more or less split along the sides; peridial cells usually seen in side view, rhomboid, 23–29 × 65–90μ, outer wall 2–3μ thick, smooth, inner and side walls 6–7μ thick, rather finely and very densely rugose with papillae of varying length; aeciospores broadly ellipsoid, 18–23 × 24–27μ, wall light cinnamon-brown, 2–2.5 μ thick, finely verrucose.

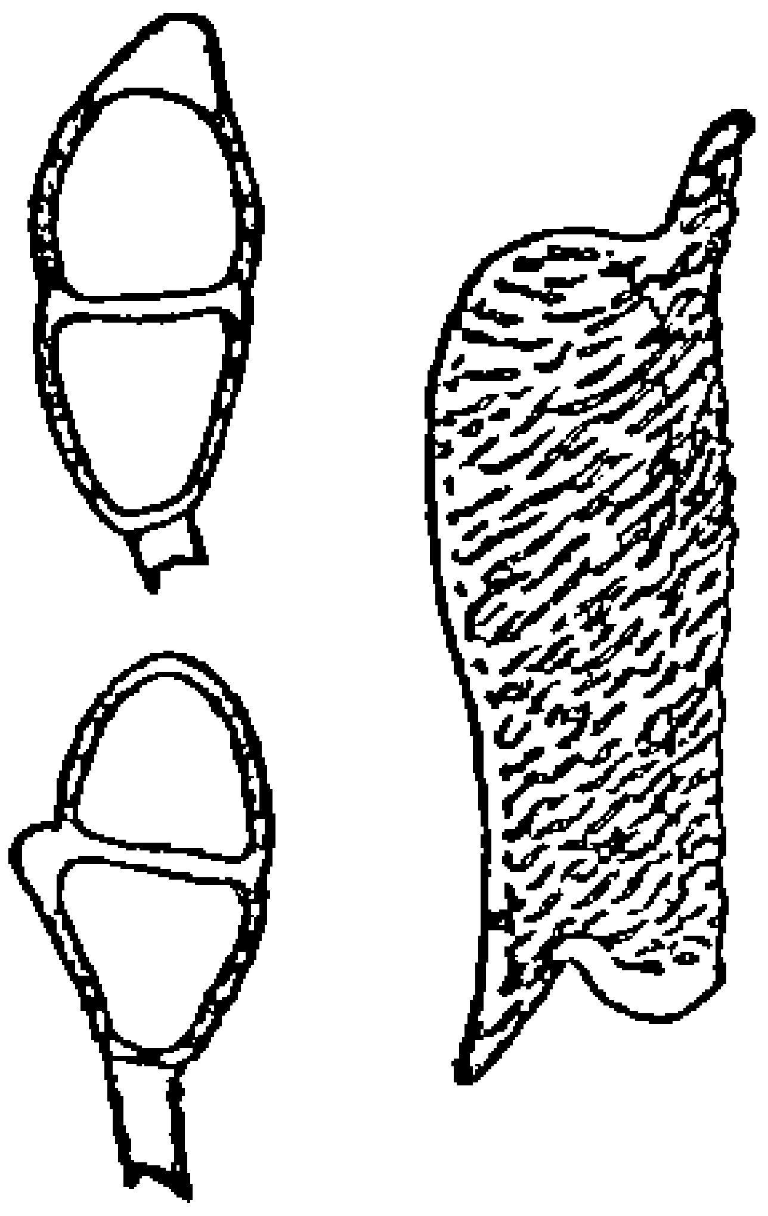

Fig. 12. *G. Torminali-juniperinum.*

Telia chiefly epiphyllous, hemispheric, 0.5–1 mm. or more high, oval or oblong, 1–2 mm. long, dark chestnut-brown, ruptured epidermis conspicuous; teliospores 2-celled, broadly ellipsoid in general outline, 21–30 × 35–49 μ, rounded or sometimes narrowed both above and below, considerably enlarged in one or two places near the septum on one or both cells owing to the presence of hyaline papillae over the germ-pores, wall cinnamon-brown, about 1.5μ thick, papillae 3–6μ; pores 1 or 2 in each cell, apical or near the septum.

Host plants:

For the aecia: *Sorbus latifolia* Pers. (*S. Aria* × *torminalis*), *S. tormimalis* Crantz.

For the telia: *Juniperus communis* L. [*J. sibirica* Burgsd.].

Type locality: Genf (Geneva), Switzerland, on *Juniperus communis.*

Distribution: Europe.

Illustration: Forst. Nat. Zeits. **4**: 348, *f. 4–13.*

Exsiccati: Eriks. Funghi Paras. Scand. *475;* Sydow, Ured. *1230;* Maire & Marg. Exsic. Hypod. Gall. Orient. *26;* Briosi & Cavara, Funghi Paras. *357;* Sydow, Myc. Mar. *4742;* Allesch. & Schn. Fungi Bavar. *216;* Roum. Fungi Gall. *2731.*

12. Gymnosporangium Davisii Kern, Bull. Torrey Club **35**: 507. 1908

Aecia hypophyllous, in irregular or rarely annular groups 1–4 mm. across, on thickened discolored spots, cylindric, acute at apex, 1.5–3 mm. high by 0.4–0.6 m. in diameter; peridium very tardily dehiscent at apex, finally becoming lacerate along the sides; peridial cells seen in both face and side views, broadly lanceolate in face view, 19–26 × 67–87μ, rhomboid in side view, 22–32 thick, outer wall 1.5–2μ thick, smooth, inner and side walls 5–8μ thick, densely rugose with closely set ridge-like papillae of vari-

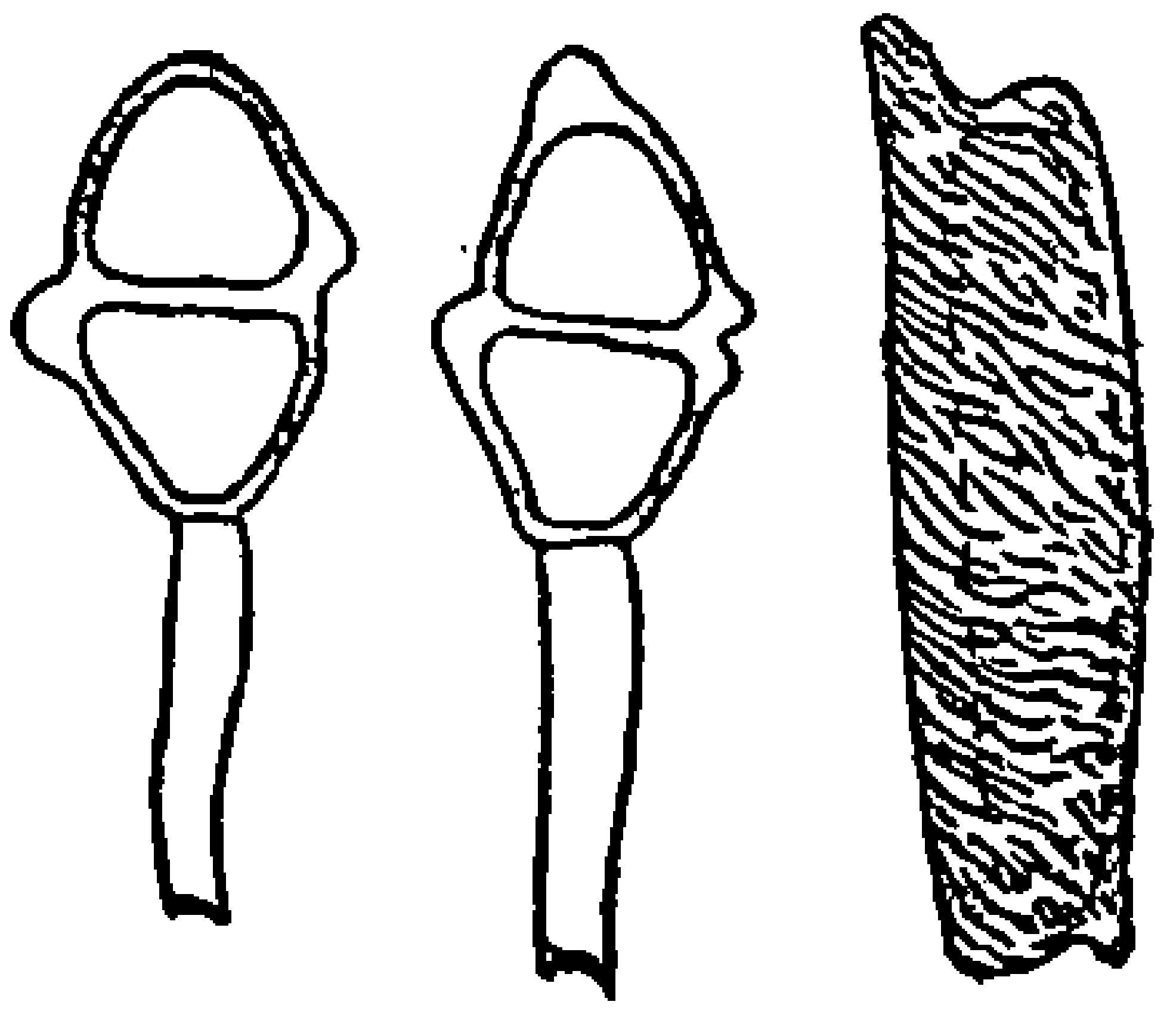

Fig. 13. *G. Davisii.*

able length; aeciospores globoid, 19–25 × 23–27µ, wall dark cinnamon-brown, 1.5–2µ thick, rather finely verrucose.

Telia chiefly epiphyllous, occasionally on the small stems at the bases of the leaves, hemispheric, 0.5–1 mm. high, oval or oblong, 0.7–1 mm. broad by 1–2 mm. long, light chocolate-brown, ruptured epidermis conspicuous; teliospores 2-celled, broadly ellipsoid in general outline, 18–28 × 40–55µ, usually narrowed below, often attenuated at apex and sometimes considerably enlarged near the septum in one or two places on one or both cells owing to the presence of hyaline papillae over the germ-pores, wall cinnamon-brown, 1–1.5µ thick, papillae 4–7µ; pores 1 or 2 in each cell, apical or near the septum.

HOST PLANTS:

For the aecia: *Aronia arbutifolia* (L.) Ell., *A. atropurpurea* Britton, *A. nigra* (Willd.) Koehne.

For the telia: *Juniperus sibirica* Burgsd. (*J. nana* Willd.).

TYPE LOCALITY: Wind Lake, Racine Co., Wisconsin, on *Juniperus sibirica.*

DISTRIBUTION: From Maine west to Michigan and Wisconsin.

13. GYMNOSPORANGIUM CUNNINGHAMIANUM Barcl. Sci. Mem. Med. Off. India **5**: 78. 1890

Tremella Cunninghamiana Arth. Proc. Ind.Acad. Sci. **1900**: 136. 1901.

Aecia hypophyllous, often in annular groups of rather large size, 6–16 mm. across, at first cylindric, 0.1–0.3 mm. in diameter, 1–2 mm. high; peridium splitting rather early, becoming deeply fimbriate; peridial cells usually seen in face view, lanceolate, 22–26 by 70–160µ, rhomboid in side view, 19–26µ thick, outer wall rather thin, about 1.5µ, inner and side walls rather thick 5–7µ, coarsely rugose with prominent ridge-like papillae; aeciospores broadly ellipsoid, 25–27 by 28–33µ, wall light chestnut-brown, 1.5–2µ thick, finely verrucose.

Telia caulicolous, with little or no hypertrophy, appearing on the smaller branches only, hemispheric or slightly tongue-shaped, 1–1.5 mm. across, chestnut-brown; teliospores 2-celled, ellipsoid, 25–30 by 56–72µ, slightly or not constricted, usually rounded above and below, wall cinnamon-brown, rather thick, 3–4µ, pores 1–2 in each cell, near the septum.

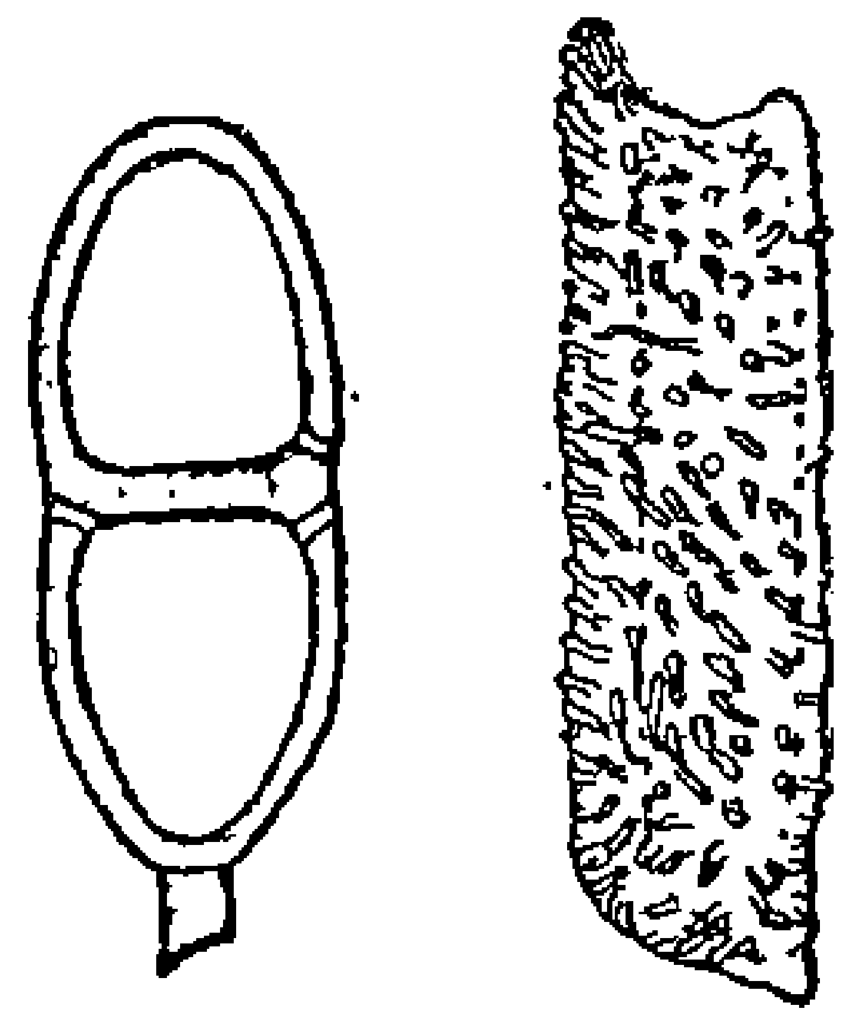

FIG. 14. *G. Cunninghamianum.*

HOST PLANTS:

For the aecia: *Pyrus variolosa* Wall. (*P. Pashia* D. Don).

For the telia: *Cupressus torulosa* Don.

Type locality: Himalaya Mts., India, on *Cupressus torulosa.*

Distribution: Known only from the type locality.

Illustration: Sci. Mem. Med. Off. India **5**^{4}: *pls. 1, 2, 3.*

14. **Gymnosporangium juvenescens** sp. nov.

Aecia chiefly hypophyllous, usually in annular groups 1–2 mm. across, cylindric, 2–4 mm. high by 0.3–0.4 mm. in diameter; peridium tardily dehiscent at apex, first rupturing by longitudinal slits along the sides; peridial cells seen in both face and side views, lanceolate-oblong in face view, 16–23 × 65–110µ, linear-rhomboid in side view, 17–27µ thick, outer wall rather thin, 1–1.5µ, smooth, inner and side walls medium thick, 5–7µ, finely and closely verrucose-rugose with irregular and oftentimes ridge-like papillae; aeciospores globoid, 18–26×21–30µ, wall chestnut-brown, 2–3µ thick, finely verrucose.

Telia caulicolous, often causing a fasciation of the young shoots and forming witches' brooms, usually causing the leaves of the affected branches to take on the subulate juvenile form, apparently arising from the axils of the leaves, hemispheric, 1–2 mm. across by 1–1.5 mm. high, cinnamon-brown; teliospores 2-celled, ellipsoid, 18–26×39–52µ, slightly or not constricted at the septum, usually rounded both above and below, wall pale cinnamon-brown, 1–2µ thick, occasionally slightly thickened over the germ-pores; pores 2 in each cell near the septum, or often only one in the upper cell and apical.

Host plants:

For the aecia: *Amelanchier alnifolia* Nutt., *A. florida* Lindl., *A. oreophila* Nels., *A. polycarpa* Greene, *A. pumila* Nutt.

For the telia: *Juniperus scopulorum* Sarg. (*Sabina scopulorum* Rydb.), *J. virginiana* L. (*S. virginiana* Antoine).

Type locality: Type collected at Boulder, Colorado, on *Juniperus scopulorum*, April 27, 1907, *Arthur, Bethel & Kern.*

Distribution: From British Columbia and Alberta southeast to the Black Hills of South Dakota and to Colorado, and locally in Nebraska and Wisconsin.

Illustration: Mycologia **3**: 158, *f. 1c, pl. 48, f. 3.*

Exsiccati: Ellis & Ev. N. Am. Fungi *3146;* Griff. W. Am. Fungi *246, 264;* Ellis & Ev. Fungi Columb. *1676;* Barth. Fungi Columb. *2527, 2580, 2977;* Vesterg. Micr. Rar. Sel. *1189;* Barth. N. Am. Ured. *108.*

The species here described under a new name is the one which the writer has been referring to in his publications as *G. Nelsoni* but recent studies, supplemented by cultures, have shown the incorrectness of this interpretation. This species nearly always produces a fasciation of the branch system, forming witches' brooms, and usually causes the leaves of the affected parts to take on the subulate juvenile form. The real *G. Nelsoni* of Arthur does not produce such distortions but appears on gall-like enlargements and appears without doubt to be identical with the writer's *G. durum*. There are also other differences in the character of the telia and teliospores. Both species have aecia on *Amelanchier*, which resemble each other very much in gross appearance, and this fact has been partially responsible for the confusion.

15. GYMNOSPORANGIUM KERNIANUM Bethel, Mycologia **3**: 157. 1911

Aecia unknown. (Cultures are now in progress but as this paper goes to press no aecia have yet developed.)

Telia caulicolous, arising between the scale-like leaves on the green twigs, causing a fasciation of the young shoots and forming globose witches' brooms 5–60 cm. in diameter, not causing a reversion to the juvenile form, scattered, usually solitary, hemispheric, 0.5–0.8 mm. across, rather compact, dark reddish-brown; teliospores chiefly 2-celled, narrowly ellipsoid, 21–26×55–74μ, narrowed or sometimes rounded at both ends, slightly or not constricted at the septum, wall thin, about 1μ, yellowish; pedicel cylindric; pores usually 2 in each cell, near the septum.

HOST PLANTS:

For the aecia: *Amelanchier* spp.

For the telia: *Juniperus utahensis* (Engelm.) Lemm. (*Sabina utahensis* Rydb.).

TYPE LOCALITY: Paonia, Colorado, on *Juniperus utahensis*.

DISTRIBUTION: Known only from western Colorado.

ILLUSTRATIONS: Mycologia **3**: 158, *f. 1a, pl. 48, f. 2*.

In the small size of the telia and in their manner of arising between the scale-like leaves, this species has a superficial resemblance to *G. inconspicuum* and *G. multiporum* but differs from them in causing witches' broom distortions of the branch-system as well as in several pronounced microscopic characters. It differs from *G. inconspicuum* in having a cylindric instead of carotiform pedicel, from both *G. inconspicuum* and *G. multiporum* in the number and arrangement of the germ-pores, and from *G. multiporum* also in the size and shape of the teliospores. In its tendency to produce witches' brooms it resembles *G. juvenescens* but differs from that species in the smaller size and different origin of the sori and especially in the greater size of the teliospores.

16. GYMNOSPORANGIUM TRACHYSORUM Kern, Mycologia **2**: 237. 1910

Aecia hypophyllous, gregarious, in irregular groups 2–5 mm. across, on discolored slightly thickened spots, cylindric, 2–4 mm. high, 0.2–0.3 mm. in diameter; peridium remaining horn-like, finally rupturing by longitudinal slits along the sides; peridial cells long and narrow in side view, 15–19×32–90µ, lanceolate in face view, 19–23µ broad, outer wall thin, 1.5–2µ, smooth or nearly so, inner and side walls moderately thick, 3–6µ, closely subspinulose with short spine-like papillae interspersed with lower oval or ridge-like papillae; aeciospores globoid or ellipsoid, 15–23 by 18–27µ, wall chestnut-brown, 2.5–3µ thick, minutely verrucose.

Telia caulicolous, appearing on abruptly fusiform or somewhat gall-like enlargements 0.5–1.5 cm. in diameter by 0.5–3 cm. long, unevenly disposed, sometimes closely aggregated, often separated by the scars of the sori of previous seasons, more or less wedge-shaped, often irregular and somewhat lacunose, 1.5–2 mm. broad by 2–4 mm. long at base by 6–10 mm. high, surface rough with irregular warts and ridges, dark chestnut-brown; teliospores 2-celled, ellipsoid, 18–21×37–45µ, wall cinnamon-brown, rather thin, 1.5–2.5µ; pores 1 or 2 in each cell near the septum.

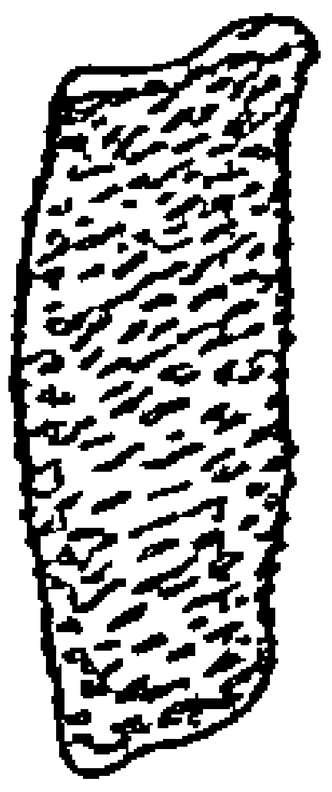

FIG. 15. *G. trachysorum.*

HOST PLANTS:

For the aecia: *Crataegus Marshallii* Eggl. (*C. apiifolia* Michx.), *C. flavo-carius* Ashe, *C. Phaenopyrum* (L. f.) Medic. (*C. cordata* Ait.).

For the telia: *Juniperus virginiana* L. (*Sabina virginiana* Antoine).

TYPE LOCALITY: Santee Canal, South Carolina, on *Juniperus virginiana.*

DISTRIBUTION: From North Carolina southwest to Mississippi and Louisiana.

17. **Gymnosporangium solenoides** (Diet.)

Roestelia solitaria Miyabe, Bot. Mag. Tokyo **17**^{2}: 35, hyponym. 1903.

Roestelia solenoides Diet. Bot. Jahrb. **32**: 631. 1903.

Gymnosporangium Miyabei Yamada & Miyake Bot. Mag. Tokyo **22**^{1}: 23. 1908.

Aecia hypophyllous, solitary or sometimes several in a group, borne in elongated protuberances of a gall-like nature, 0.2–0.3 mm. in diameter, 2–3 mm. high; peridium dehiscent at apex, not becoming much lacerate; peridial cells usually seen in both face and side views, rhombic or rhomboid in side view, very thick, 42–55μ thick by 65–90μ long, outer wall moderately thin 3–5μ, smooth, inner wall thick, 7–13μ, moderately and densely verrucose with small oval or slightly irregular papillae, side walls verrucose similarly to inner wall on inner half, remainder smooth; aeciospores globoid, 18–24μ in diameter, wall cinnamon-brown, thin, 1–1.5μ, finely verrucose.

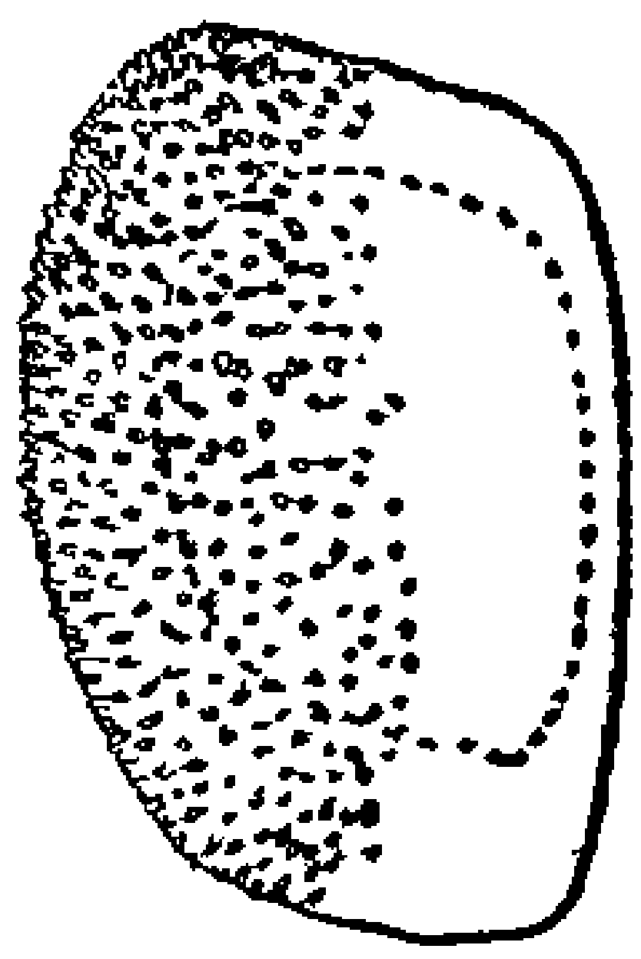

FIG. 16. *G. solenoides.*

Telia caulicolous, appearing on irregular fusiform enlargements with a knotty rough surface, at first covered by the periderm, soon breaking forth, pulvinate or somewhat wart-shaped, often confluent, 2–3 mm. across, often much longer, reddish-brown; teliospores 2–3-celled, narrowly ellipsoid, 11–20 by 41–80μ, rounded or slightly narrowed at both ends, wall medium thin, brownish; pores usually 1 in a cell and apical, sometimes near the septum in the upper cell and near the pedicel in the lower.

HOST PLANTS:

For the aecia: *Sorbus Aria* Crantz (*Pyrus aria* Ehrh.), *Sorbus alnifolia* K. Koch (*Pyrus Miyabei* Sarg.).

For the telia: *Chamaecyparis pisifera* Sieb. & Zucc.

TYPE LOCALITY: Prov. Iwaki, Japan, on *Pyrus Aria* (var. *Kamaonensis*).

DISTRIBUTION: Japan.

ILLUSTRATION: Bot. Mag. **22**: *f. 1–9.*

18. **Gymnosporangium tubulatum** comb. nov.

Roestelia tubulata Kern; Jones, Univ. Mont. Bull. **61**: 64. 1910.

Aecia chiefly hypophyllous, crowded in irregular groups on thickened discolored spots, cylindric, acutish at apex, 2–3.5 mm. high by 0.2–0.4 mm. in diameter; peridium firm, tardily dehiscent by longitudinal slits in the lower part; peridial cells fusiform-oblong in face view, 18–26×48–80μ, oblong in side view, 16–24μ thick, outer wall rather thin, 1–1.5μ, smooth, inner and side walls rather thick, 5–6μ, densely and moderately rugose with ridges of varying length; aeciospores globoid or broadly ellipsoid, 18–22×21–28μ, wall light chestnut-brown, 1.5–2.5μ thick, finely verrucose.

Telia unknown.

Host plants:

For the aecia: *Crataegus Douglasii* Lindl. (*C. brevispina* Dougl.), *C. Williamsii* Eggl.

For the telia: unknown.

Type locality: Near Flathead Lake, Montana, on *Crataegus Douglasii.*

Distribution: Known only from western Montana.

19. GYMNOSPORANGIUM BOTRYAPITES (Schw.) Kern, Bull. Torrey Club **35**: 506. 1908

Caeoma (*Roestelia*) *Botryapites* Schw. Trans. Am. Phil. Soc. II. **4**: 294. 1832.

Ceratites (*Caeoma*) *Botryapites* Schw. Trans. Am. Phil. Soc. II. **4**: 310. 1832.

Gymnosporangium biseptatum Ellis, Bull. Torrey Club **5**: 46. 1874.

Roestelia Ellisii Peck, Bull. Torrey Club **6**: 13. 1875.

Roestelia Botryapites Cooke & Ellis, Grev. **5**: 34. 1876.

Puccinia Botryapites Kuntze, Rev. Gen. Pl. **3**: 508. 1898.

Tremella Botryapites Arth. Proc. Ind. Acad. Sci. **1900**: 135. 1901.

Aecia hypophyllous, usually in groups of 2–8, rarely solitary, borne in gall-like pyriform protuberances 1–1.5 mm. in diameter by 1.5–3 mm. high, cylindric, 0.5–0.8 mm. in diameter by 2–4 mm. high; peridium soon becoming finely cancellate, not dehiscent at apex; peridial cells cylindric, hyphal-like, 9–14μ in diameter by 145–190μ long, often irregularly bent, outer, inner, and side walls of equal thickness, about 1.5–2μ, whole surface smooth; aeciospores globoid, small, 15–17×16–22μ, wall dark cinnamon-brown, rather thick, 2.5–3μ, moderately verrucose.

Telia caulicolous, appearing on fusiform swellings, scattered, oval or irregular, about 1.5–3 mm. wide by 2–7 mm. long, often confluent, hemispheric, chestnut-brown; teliospores 2–4 celled, 13–19×35–77μ, usually rounded above, somewhat narrowed below, slightly constricted at the septa, wall pale yellow, 1–1.5μ thick, pores 2 in each cell, near the septa.

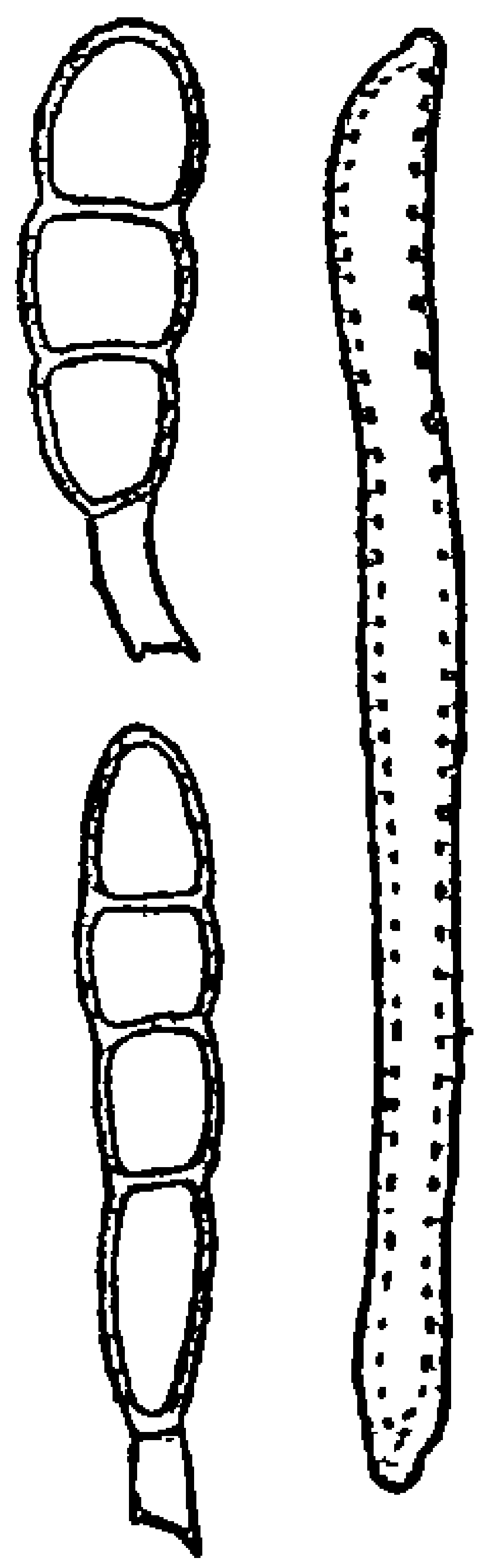

Fig. 17. *G. Botryapites.*

Host plants:

For the aecia: *Amelanchier canadensis* (L.) Medic. (*Amelanchier Botryapium* DC.), *A. intermedia* Spach.

For the telia: *Chamaecyparis thyoides* (L.) B.S.P. (*Chamaecyparis sphaeroidea* Spach, *Cupressus thyoides* L.).

TYPE LOCALITY: Bethlehem, Pennsylvania, on *Aronia Botryapium* [=*Amelanchier canadensis*].

DISTRIBUTION: Along the Atlantic coast from Massachsetts to New Jersey and Pennsylvania and in southern Alabama.

ILLUSTRATIONS: Hedwigia **34**: 3, *f. 10;* Farlow, Anniv. Mem. Boston. Soc. Nat. Hist. *pl. 2, f. 18–21;* Bot Gaz. **49**: *pl. 22, f. 12.*

EXSICCATI: Seym. & Earle, Econ. Fungi *243, 245;* Rab.-Wint. Fungi. Eur. *2922;* Ellis & Ev. Fungi Columb. *1075;* Ellis, N. Am. Fungi *272; 1087;* Thüm. Myc. Univ. *431;* Roum. Fungi Sel. *4534.*

20. GYMNOSPORANGIUM NIDUS-AVIS Thaxt. Bull. Conn. Exper. Sta. 107: 3. 1891

Roestelia Nidus-avis Thaxt. Bull. Conn. Exper. Sta. 107: 5. 1891.
Puccinia Nidus-avis Kuntze, Rev. Gen. Pl. **3**: 507. 1898.
Tremella Nidus-avis Arth. Proc. Ind. Acad. Sci. **1900**: 136. 1901.
Aecidium Nidus-avis Farlow, Bibl. Index **1**: 68. 1905.

Aecia amphigenous, especially fruiticolous, cylindric, 2–4 mm. high by 0.4–6.7 mm. in diameter; peridium soon becoming irregularly lacerate usually to base, slightly spreading; peridial cells seen in both face and side views, lanceolate in face view, 15–23×55–88µ, linear in side view, 14–18 µ thick, outer wall 1–1.5µ thick, smooth, inner and side walls 5–7µ thick, coarsely rugose with narrow ridges, with shorter often roundish papillae interspersed; aeciospores globoid or broadly ellipsoid, 18–23×23–28µ, wall cinnamon-brown, rather thick, 2.5–4µ, very finely verrucose, appearing almost smooth when wet.

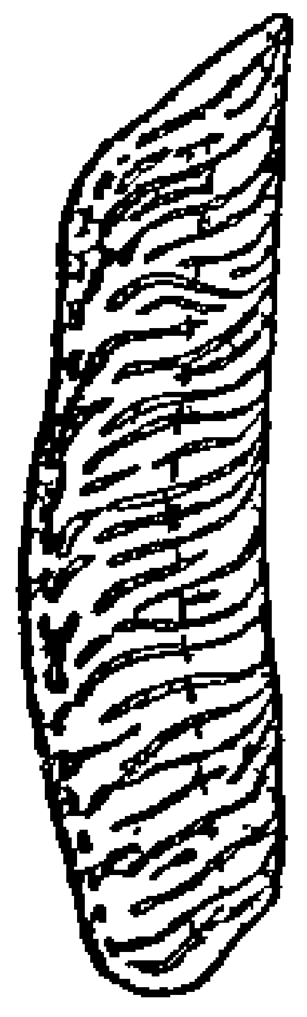

FIG. 18. *G. Nidus-avis.*

Telia caulicolous, often dwarfing the young shoots and causing bird's nest distortions or witches' brooms, usually causing a reversion of the leaves to the juvenile form, sometimes appearing on isolated areas on the larger branches and producing gradual enlargements, solitary or rarely confluent, of variable size and shape, roundish to oval on the young shoots, 1–2 mm. across, oval to narrowly elliptic on the woody branches, 1.5–3 mm. wide by 2–7 mm. long, pulvinate when young becoming hemispheric, dark reddish-brown; teliospores 2-celled, ellipsoid, 16–23×39–55µ, wall pale cinnamon-brown, rather thin, 1–1.5µ, very slightly thicker at apex; pores one in a cell, apical.

HOST PLANTS:

For the aecia: *Amelanchier canadensis* (L.) Medic., *A. erecta* Blanch., *A. intermedia* Spach., *A. oblongifolia* (Torr. & Gray) Roem., *A. vulgaris* Moench (cult.), *Cydonia vulgaris* (L.) Pers.

For the telia: *Juniperus virginiana* L.

TYPE LOCALITY: Connecticut, on *Juniperus virginiana.*

DISTRIBUTION: Massachusetts west to Wisconsin and Iowa, south to Florida and Mississippi.

ILLUSTRATION: Bot. Gaz. **49**: *pl. 22, f. 10.*

EXSICCATI: Rab.-Wint. Fungi Eur. *2923;* Ellis, N. Am. Fungi *1083b, 1086c;* Seym. & Earle, Econ. Fungi *239, 240;* Ellis & Ev. Fungi Columb. *1623;* Ellis & Ev. N. Am. Fungi *3145;* Rav. Fungi Am. *791;* Kellerm. Ohio Fungi *185;* Rav. Fungi Carol. **5**: *87.*

21. GYMNOSPORANGIUM EXTERUM Arth. & Kern; Arth. Mycologia **1**: 254. 1909

Aecia hypophyllous, very sparsely disposed in large groups 4–10 mm. across, on discolored spots, 0.1–0.3 mm. in diameter by 0.5–0.8 mm. high; peridium soon becoming rather finely lacerate almost to base, spreading but not revolute; peridial cells usually seen only in face view, lanceolate, 10–18×58–100μ, inner wall rugose with narrow ridges, side walls 3–5μ thick, sculptured over whole surface like inner wall; aeciospores broadly ellipsoid or globoid, 17–21×21–26μ, wall very pale cinnamon-brown, 2–2.5μ thick, very finely verrucose.

Telia caulicolous, appearing on fusiform dwellings 2–6 cm. long by 0.5–1.5 cm. or more in diameter, causing a considerable roughening and exfoliation of the bark, flattened and applanate, irregular and indefinite in outline, usually anastomosing over practically the whole surface of a swelling, light chocolate-brown; teliospores 2-celled, 18–23 ×32–42μ, very slightly or not at all constricted at the septum, wall light cinnamon-brown, rather thin, 1–1.5μ, usually slightly thicker at apex; pores one in a cell, apical.

HOST PLANTS:

For the aecia: *Porteranthus stipulatus* (Muhl.) Britton (*Gillenia stipulacea* Nutt., *Spiraea stipulata* Muhl.).

For the telia: *Juniperus virginiana* L.

TYPE LOCALITY: Mammoth Cave, Kentucky, on *Juniperus virginiana.*

DISTRIBUTION: Small area from Central Kentucky to southeastern Missouri.

EXSICCATI: Rab.-Wint. Fungi Eur. *3323.*

22. GYMNOSPORANGIUM GERMINALE (Schw.) Kern, Bull. Torrey Club **35**: 506. 1908

Caeoma (*Peridermium*) *germinale* Schw. Trans. Am. Phil. Soc. II. **4**: 294. 1832.

Peridermium (*Caeoma*) *germinale* Schw. Trans. Am. Phil. Soc. II. **4**: 310. 1832.

Podisoma Gymnosporangium clavipes Cooke & Peck, Jour. Quek. Cl. **2**: 267. 1871.

Gymnosporangium clavipes Cooke & Peck, Ann. Rep. N. Y. State Mus. **25**: 89. 1873.

Roestelia aurantiaca Peck, Ann. Rep. N. Y. State Mus. **25**: 91. 1873.

Puccinia clavipes Kuntze, Rev. Gen. Pl. **3**: 507. 1898.

Tremella clavipes Arth. Proc. Ind. Acad. Sci. **1900**: 135. 1901.

Aecidium aurantiacum Farlow, Bibl. Index **1**: 19. 1905. Not *A. aurantiacum* Bon. 1860.

Aecidium germinale Arth. Résult. Sci. Congr. Bot. Vienne 343. 1906.

Aecia fruiticolous and caulicolous, crowded on hypertrophied areas of variable size on the twigs and peduncles, occupying part or nearly all of the surface of the fruits, cylindric, 1.5–3 mm. high by 0.3–0.5 mm. in diameter; peridium whitish, becoming coarsely laceate, sometimes to base, erect or spreading; peridial cells seen in both face and side views, polygonal-ovate or polygonal oblong in face view, 19–39×45–95μ, rhomboid in side view, 25–40μ thick, outer wall moderately thick, 3–5μ, inner wall very thick, 13–23μ, coarsely verrucose with loosely set, large, irregularly branched papillae, side walls verrucose on inner half similar to inner wall; aeciospores globoid, large, 21–32×24–39μ, wall pale yellow, thick, 3–4.5μ, rather coarsely verrucose with crowded slightly irregular papillae.

Telia caulicolous, appearing on slight fusiform swellings, usually aggregated, roundish, 1–4 mm. across, often confluent, hemispheric, 1–3 mm. high, orange-brown; teliospores 2-celled, ellipsoid, 18–26×35–51μ, roundish or somewhat acutish above, obtuse below, slightly or not constricted at the septum, wall yellowish, 1–2μ thick, slightly thicker at the apex; pedicels carotiform, 9–19μ in diameter near the spore; pores one in each cell, apical in the upper, near the pedicel in the lower.

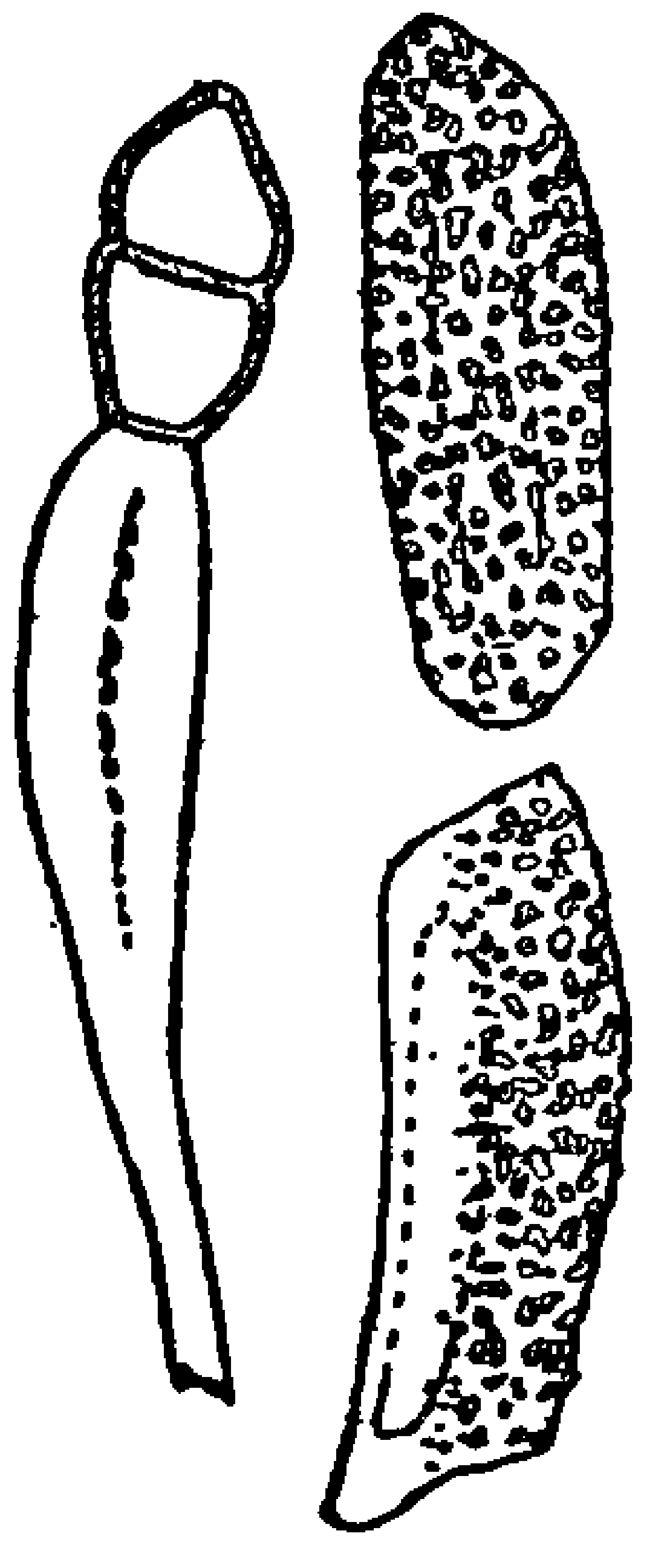

FIG. 19. *G. germinale*

Host plants:

For the aecia: *Amelanchier canadensis* (L.) Medic., *A. erecta* Blanch., *A. intermedia* Spach., *A. oligocarpa* (Michx.) Roem., *A. oblongifolia* (Torr. & Gray) Roem., *A. rotundifolia* (Michx.) Roem., *Aronia arbutifolia* (L.) Ell., *A. atropurpurea* Britton, *A. nigra* (Willd.) Britton, *A. monstrosa* Zabel (*A. arbutifolia*×*Sorbus americana*), *Crataegus colonica* Beadle, *C. crus-galli* L., *C. dispar* Beadle, *C. flava* Ait., *C. Jonesae* Sarg., *C. mollis* (Torr. & Gray) Scheele, *C. punctata* Jacq., *C. Reverchoni* Sarg., *C. rotundifolia* Moench, *C. spatulata* Michx., *Cydonia vulgaris* (L.) Pers., *C. japonica* (Thunb.) Pers. (*Chaenomeles japonica* Lindl.), *Malus Malus* (L.) Britton (*Pyrus Malus* L.).

For the telia: *Juniperus communis* L., *J. sibirica* Burgsd. (*J. nana* Willd.), *J. virginiana* L.

Type locality: Philadelphia, Pennsylvania, "in germinibus Rosae," error for *Crataegus*.

Distribution: From Maine west to northern peninsula of Michigan and Iowa, south to northern Florida and Texas.

Illustrations: Hedwigia **34**: 3, *f. 7;* Bot. Gaz. **49**: *pl. 21, f. 9.*

Exsiccati: Seym. & Earle, Econ. Fungi *234, 235, 236, 237, 238;* Rav. Fungi Am. *271, 272, 502;* Ellis, N. Am. Fungi *1083a, 1084;* Ellis & Ev. N. Am. Fungi *2224;* Ellis & Ev. Fungi Columb. *54, 1732;* Thüm. Myc. Univ. *44*; Kellerm. Ohio Fungi *21.*

23. Gymnosporangium juniperinum (L.) Mart. Fl. Crypt. Erlang. 333. 1817

Tremella juniperina L. Sp. Pl. 1157. 1753.
Aecidium penicillatum Pers. in J. F. Gmel. Syst. Nat. **2**: 1472. 1791.
Caeoma penicillatum Schlecht. Fl. Berol. **2**: 111. 1824.
Centridium Ariae Desm. Pl. Crypt. *1378.* 1845.
Roestelia penicillata Fries, Sum. Veg. Scand. **2**: 510. 1849.
Ceratitium penicillatum Rabenh. Bot. Zeit. **9**: 452. 1851.
?*Podisoma Gymnosporangium* Bon. Handb. 148. 1851.
Podisoma tremelloides A. Braun, Bot. Zeit. **25**: 94. 1867.
Gymnosporangium tremelloides R. Hartig, Lehr. Baumkr. **1**: 333. 1882.
Puccinia juniperina Kuntze, Rev. Gen. Pl. **3**: 507. 1898.
Tremella penicillata Arth. Proc. Ind. Acad. Sci. **1900**: 135. 1901.

Roestelia fimbriata Arth. Bull. Torrey Club **28**: 666. 1901.
Aecidium fimbriatum Farlow, Bibl. Index **1**: 44. 1905.
Gymnosporangium penicillatum Liro, Ured. Fenn. 405. 1908.

Aecia hypophyllous, in annular or crowded groups, 2–5 mm. across, on larger thickened discolored spots, at first cylindric, 0.5–1.5 mm. high, 0.5–1 mm. in diameter; peridium soon becoming finely fimbriate to base and somewhat twisted or incurved; peridial cells usually seen only in side view, rhomboid, very thick, 30–35 × 60–90µ, outer wall medium thin, 2–3µ, smooth, inner wall medium thick, 7–10µ, rugose, side walls very coarsely rugose with thick, somewhat irregular ridges, roundish or elongate ridge-like papillae interspersed; aeciospores globoid, very large, 28–35 × 30–45µ, wall chestnut-brown, thick, 3–5µ, rather finely verrucose.

Telia caulicolous, appearing on hemispheric swellings (1–4 cm. long) breaking forth along the sides of the larger branches, or on subglobose galls (1.5–2 cm. in diameter) on the smaller branches, applanate, indefinite, usually of considerable size, often covering the whole hypertrophied area, sometimes becoming patelliform when expanded, chocolate-brown; teliospores 2-celled, ellipsoid 18–28 × 42–61µ, usually slightly narrowed both above and below, slightly or not constricted at the septum, wall cinnamon-brown, 1–1.5µ thick; pores usually 3 in the upper cell, 1 apical, 2 near the septum, in the lower cell 2 near the septum.

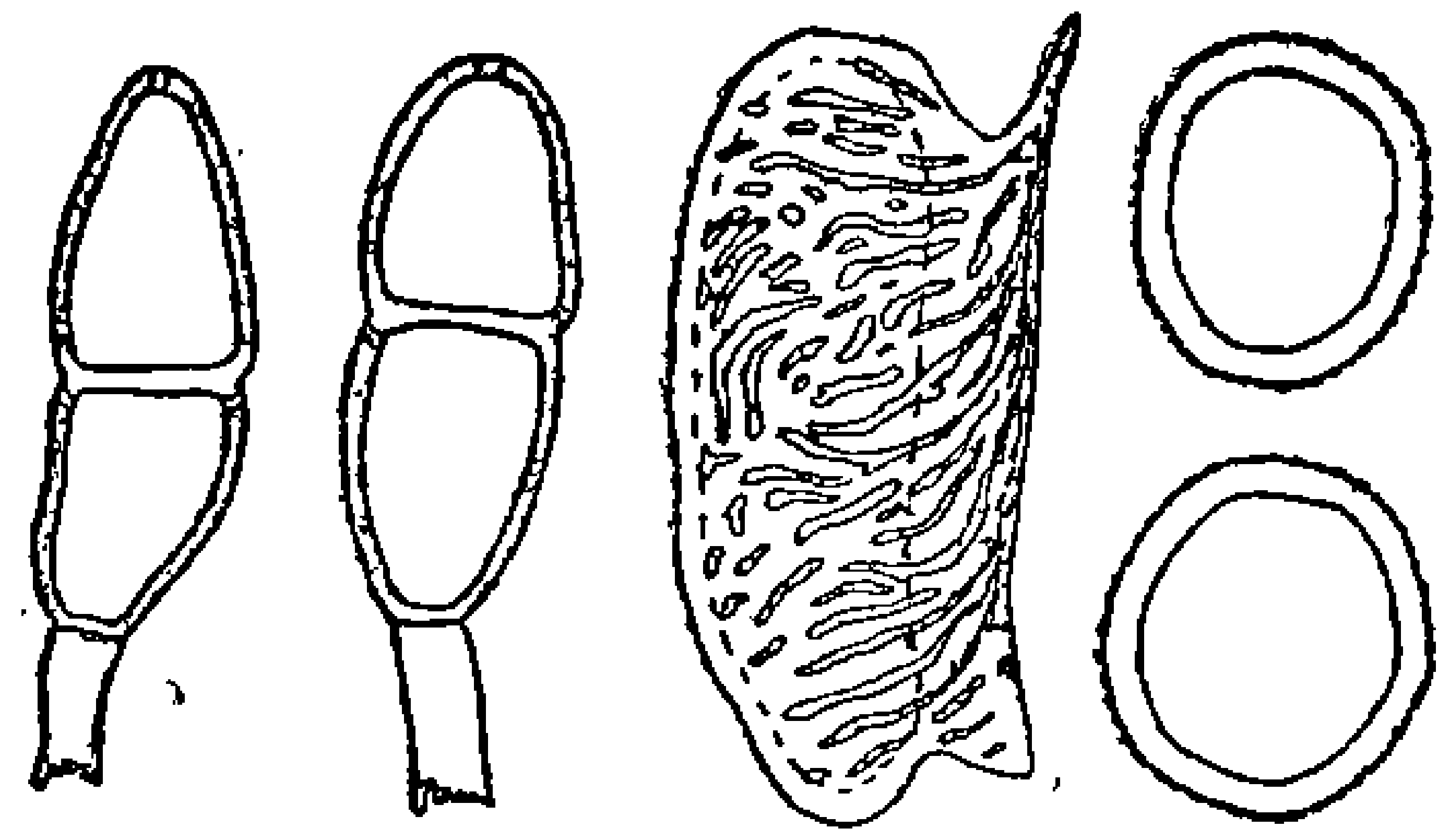
FIG. 20. *G. juniperinum.*

HOST PLANTS:

For the aecia: *Malus Malus* (L.) Britton (*Pyrus Malus* L.) (in Europe only), *Sorbus Aria* Crantz, *S. Chaemaemespilus* Crantz, *S. Hostii* Koch (*S. Aria*×*Chaemaemespilus*), *S. hybrida* L. (*S. Aria*× *aucuparia*), *S. latifolia* Pers. (*S. Aria*×*torminalis*), *S. occidentalis* (Wats.) Greene, *S. scopulina* Greene, *S. sitchensis* Roem.

For the telia: *Juniperus communis* L., *J. sibirica* Burgsd. (*J. nana* Willd.).

TYPE LOCALITY: Sweden, on *Juniperus* [*communis*].

DISTRIBUTION: Rocky Mountains from Alberta and British Columbia south to Colorado; and in Europe.

ILLUSTRATIONS: Beitr. Krypt. Schweiz. **2**^{2}: *f. 277;* Hedwigia **34**: 3, *f. 1;* Bot. Gaz. **49**: *pl. 21, f. 8;* E. & P. Nat. Pflanzenfam. **1**^{1**}: *f. 33, C, D, E;* Forst. Nat. Zeits. **4**: 348, *f. 1–3, 14–16.*

Exsiccati: Briosi & Cavara, Funghi Paras. *161, 163;* Sydow, Ured. *380, 585, 799, 1288, 1289, 1885;* Linhart, Fungi Hung. *39, 132, 245;* Roum. Fungi Sel. *7339;* Sacc. Myc. Ital. *457, 921, 1096;* Sacc. Myc. Venet. *398;* Sydow, Myc. Mar. *1816;* Eriks. Fungi Par. Scand. *75, 180;* Rab. Fungi Eur. *1390;* Rab.-Wint.-Paz. Fungi Eur. *4015;* Rab. Herb. Mycol. *788;* Desm. Pl. Crypt. *1378;* Thüm. Myc. Univ. *745, 1122;* West. & Wall. Herb. Crypt. *1064.*

Although the writer has previously given brief statements (Kern, 1908[1], 1908[2]) of his disposition of the specific name *juniperinum* a further explanation seems desirable. It seems clear from the literature that Linnaeus and the writers who followed him for a hundred years or more used this name to refer to a large conspicuous form such as is known to belong with *Roestelia penicillata.* Oersted (1866[1]) is responsible for introducing the use of the name *juniperinum* for the smaller and less conspicuous form which he culturally connected with *Roestelia cornuta.* European writers since the time of Oersted have been uncertain in the use of this name. Recently Fischer (1909, 1910) has shown by cultures that at least three distinct species have quite generally been included by most European authors under this name. He separates out under the name *G. Amelanchieris,* a small twig-inhabiting form belonging with an aecial form on *Amelanchier,* and under the name *G. Torminali-juniperinum* an inconspicuous leaf-inhabiting form producing its aecial phase on *Sorbus torminalis.* By a sort of process of elimination he retains the name *juniperinum* for the form related to *Roestelia cornuta* on *Sorbus Aucuparia.* In this, Fischer follows Oersted but since the evidence indicates he was originally responsible for a misuse of the name the writer hesitates to accept this interpretation. The disposition of the name *juniperinum,* previously suggested by the writer and here retained, appears to be in accordance with the prior conception.

24. **Gymnosporangium gracilens** (Peck) Kern & Bethel.

Aecidium gracilens Peck, Bot. Gaz. **4**: 128. 1879.
Gymnosporangium speciosum Peck, Bot. Gaz. **4**: 217. 1879.
Aecidium Rusbyi Gerard, Bull. Torrey Club. **8**: 34. 1881.
Tremella speciosa Arth. Proc. Ind. Acad. Sci. **1900**: 35. 1901.

Aecia hypophyllous, in small groups 2–5 mm. across, on discolored spots, cylindric, 0.3–0.4 mm. in diameter by 2–3 mm. high; peridium dehiscent at apex, retaining tubular form, margin rather deeply lacerate; peridial cells seen in both face and side views, rhomboid or linear-rhomboid in side view, 31–39×71–98µ, broadly lanceolate in face view, 23–32µ broad, moderately and densely verrucose over entire surface with high, slender, and somewhat irregular papillæ, outer wall 3–4µ thick, inner wall 10–15µ thick; aeciospores subgloboid, 21–24×24–29µ, wall pale yellow, 2.5–3.5µ thick, finely verrucose.

Telia caulicolous, appearing on long fusiform swellings, arranged in more or less evident longitudinal rows, cristiform, laterally compressed, irregularly crenate above, 2–7 mm. long, 1–1.5 mm. broad, 3–4 mm. high, sometimes confluent, orange yellow; teliospores 2–3-celled, ellipsoid or oblong, 20–26×50–80µ, rounded above and below, slightly constricted at the septa, wall pale yellow, thin, about 1µ; pores 2 in each cell, near the septa.

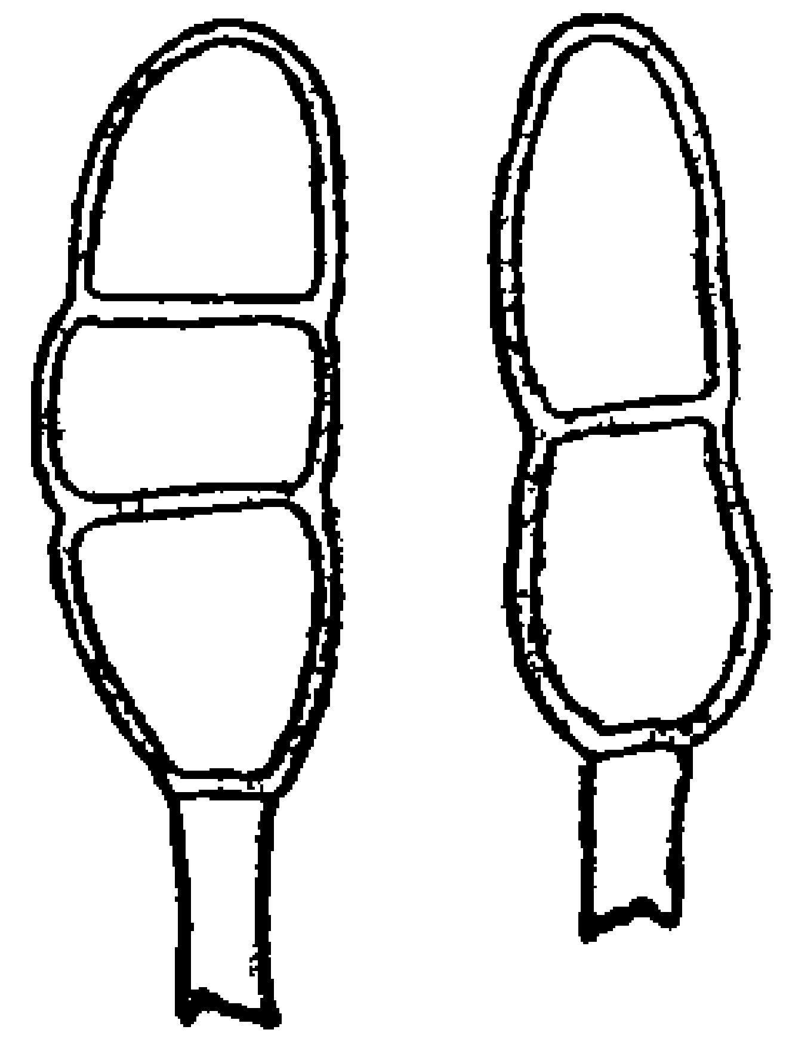
FIG. 21. *G. gracilens.*

HOST PLANTS:

For the aecia: *Fendlera rupicola* Engelm. & Gray, *F. Wrightii* Heller, *Philadelphus ellipticus* Rydb., P. *microphyllus* A. Gray, *P. occidentalis* A. Nels.

For the telia: *J. monosperma* (Engelm.) Sarg. (*Sabina monosperma* Rydb.), *J. pachyphlaea* Torr. (*Sabina pachyphlaea* Antoine), *J. utahensis* (Engelm.) Lemm. (*S. utahensis* Rydb.).

TYPE LOCALITY: Colorado, on *Philadelphus microphyllus.*

DISTRIBUTION: Colorado southwest into New Mexico and Arizona.

It has recently been suggested by Bethel (1911) that *Aecidium gracilens* Peck on *Philadelphus spp.* is the probable aecial stage of this species. I am especially glad to be able to report that cultures have since been made which prove the correctness of Professor Bethel's keen observations. This result is unusually noteworthy because *Philadelphus* does not belong to the Malaceae or Rosaceae, the only two families previously known to bear aecia of the heteroecious species of *Gymnosporangium*, but to the Hydrangiaceae.

25. **Gymnosporangium effusum** sp. nov.

Aecia unknown.

Telia caulicolous, usually appearing on branches 0.3–1.5 cm. in diameter, causing long slender fusiform enlargements 0.5–2.5

by 15–40 cm., extending into and causing some swelling of the smaller branches and twigs arising from the infected areas, sometimes appearing on larger branches, usually breaking forth in series along the branch, unevenly disposed, hypertrophied scars of the sori of previous seasons frequently interspersed, somewhat wedge-shaped, often irregular and lacunose, sometimes forked or divided, 2–3 mm. broad by 2–5 mm. long at the base, 7–10 mm. high, dark chestnut-brown; teliospores 2-celled, oblong-ellipsoid, 16–22 by 45–55μ, rounded or slightly narrowed both above and below, slightly constricted at the septum, wall dark cinnamon-brown, rather thin, 1–2μ; pores 1–2 in each cell, near the septum.

HOST PLANTS:

For the aecia: unknown.

For the telia: *Juniperus virginiana* L.

Type collected at Santee Canal, S. C., on *Juniperus virginiana*, March 18, 1909, *Frank D. Kern.*

DISTRIBUTION: Along the Atlantic coast from New York south to South Carolina.

In the generally wedge-shaped telia with their rough and irregular surfaces, especially noticeable when expanded, this species resembles *G. trachysorum* but in the character of the hypertrophies upon which the telia appear the two species are quite distinct. This species is very destructive to the cedars on account of its habit of attacking and spreading along the larger branches.

26. GYMNOSPORANGIUM JAPONICUM Sydow, Hedwigia Beib. **38**: 141. 1899

Roestelia koreaensis P. Henn. Monsunia **1**: 5. 1900.

Tremella koreaensis Arth. Proc. Ind. Acad. Sci. **1900**: 136. 1901.

Aecia hypophyllous, in crowded or somewhat annular groups, on thickened discolored spots, cylindric, 0.4–0.5 mm. in diameter by 2–3 mm. high; peridium soon becoming irregularly lacerate and cancellate often to base, erect or slightly spreading; peridial cells seen in both face and side views, broadly lanceolate or oval in face view, 29–32 by 64–90μ, oblong in side view, 23–32μ thick, coarsely rugose on inner and side walls, the ridges becoming much higher on side walls and extending clear across, outer wall 1.5–2μ thick, inner and side walls 5–7μ; aeciospores globoid, 18–21 by 19–23μ, wall pale cinnamon-brown, medium, 1.5–2μ thick, very finely verrucose.

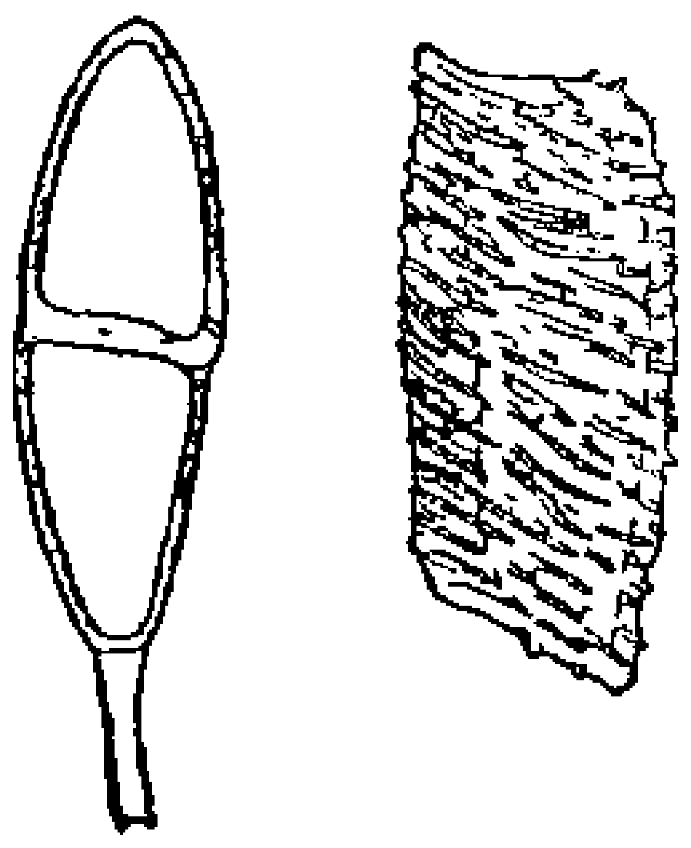

FIG. 22. *G. japonicum.*

Telia caulicolous, appearing on gradual fusiform enlargements, scattered, irregularly wedge-shaped, often incised at apex and lacunose below, 3–5 mm. high, cinnamon-brown; teliospores 2-celled, ellipsoid, 18–22 by 57–66µ, not or very slightly constricted, usually narrowed above and below, wall pale cinnamon-brown, rather thin, 1–1.5µ; pores 2 in each cell, near the septum.

HOST PLANTS:

For the aecia: *Pyrus sp.* (Has been cultivated on *Pyrus sinensis* Lindl.)

For the telia: *Juniperus chinensis* L.

TYPE LOCALITY: Tokyo, Japan, on *Juniperus chinensis.*

DISTRIBUTION: Japan and Korea. (Recently reported in the United States by Clinton on *J. chinensis* imported from Japan.)

ILLUSTRATIONS: Zeits. f. Pflanzenkr. **10**: *pl. 1–2.*

EXSICCATI: Sydow, Ured. *1287.*

27. GYMNOSPORANGIUM SABINAE (Dicks.) Wint. in Rab. Krypt. Fl. **1**^{1}: 232. 1884

Tremella Sabinae Dicks. Pl. Crypt. Brit. **1**: 14. 1785.
Aecidium cancellatum Pers. in J. F. Gmelin, Syst. Nat. **2**^{2}: 1472. 1791.
Roestelia cancellata Rebent. Fl. Neom. 350. 1804.
?*Gymnosporangium conicum* Hedw. f.; DC. Fl. Fr. **2**: 216. 1805.
Gymnosporangium fuscum Hedw. f.; DC. Fl. Fr. **2**: 217. 1805.
Caeoma Roestelites Link, in Willd. Sp. Pl. **6**^{2}: 64. 1825.
Podisoma Juniperi Link, in Willd. Sp. Pl. **6**^{2}: 127. 1825.
Cyglides calyptratum Chev. Fl. Env. Paris **1**: 384. 1826.

Aecia hypophyllous, gregarious, on thickened discolored spots, large, balaniform, 0.5–1 mm. broad at the base by 1–2 mm. high; peridium soon becoming cancellate along the sides, apex bluntly conic; peridial cells usually seen in side view, rhomboid or linear-rhomboid, 18–23 by 66–98µ, inner and side walls moderately verrucose with roundish or oval-papillae; aeciospores globoid, 23–29 by 26–32µ, wall light chestnut-brown, rather thick, 3–4µ, finely verrucose.

Telia caulicolous, causing very slight or no enlargements, conic or laterally compressed, 6–10 mm. or more long, often somewhat lacunose, chestnut-brown; teliospores 2-celled ellipsoid, 19–30 by 37–48µ, usually narrowed at both ends, usually slightly constricted at the septum, wall cinnamon-brown to light chestnut-brown, 2–3µ thick; pores 2 in each cell, near the septum.

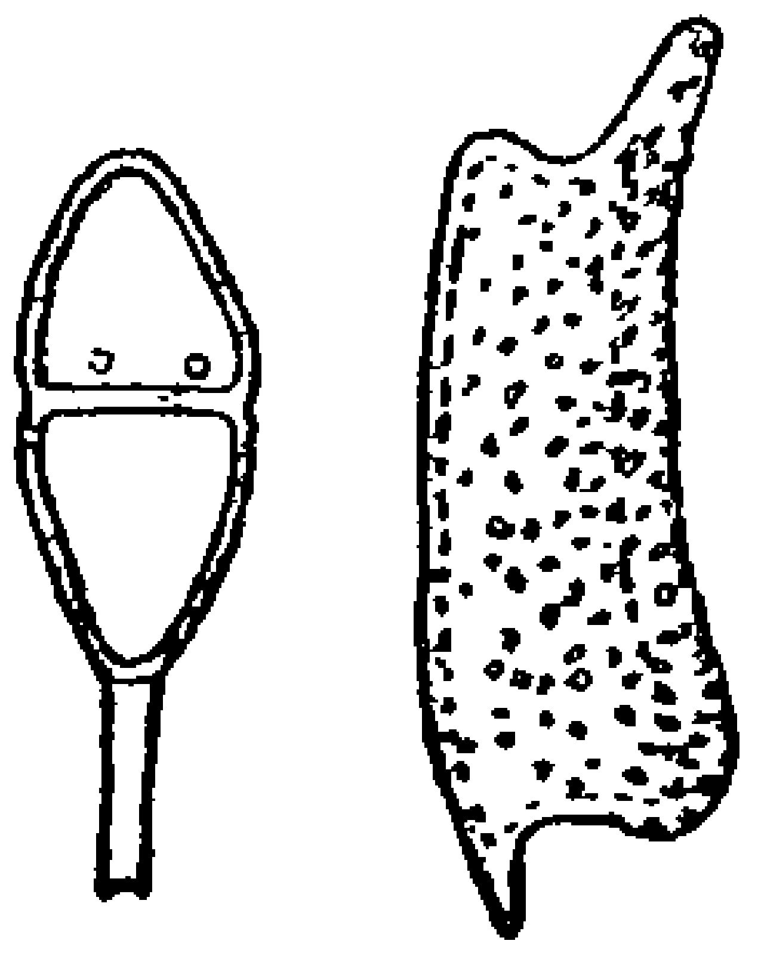

FIG. 23. *G. Sabinae.*

HOST PLANTS:

For the aecia: *Pyrus betulifolia* Bunge, *P. communis* L., *P. eleaginifolia* Pall., *P. Michauxii* (hort), *P. nivalis* Jacq., *P. salicifolii* L., *P. tomentosa* Moench.

For the telia: *Juniperus chinensis* L., *J. japonica* Carr., *J. phoenica* L., *J. Sabina* L., *J. sphaerica* Lindl., *J. tripartita* (hort), *J. virginiana* L.

DISTRIBUTION: Europe.

ILLUSTRATIONS: Beitr. Krypt. Schweiz **2**^{2}: *f. 279;* Hedwigia **34**: 3, *f. 4;* E. & P. Nat. Pflanzenfam. **1**^{1**}: *f. 32.*

EXSICCATI: Sacc. Myc. Ital. *709;* Sydow, Ured. *86, 87, 88, 379, 1435, 1436;* Sydow, Myc. Mar. *72, 427, 2510, 2746, 2747, 3128, 4126;* Eriks. Fungi Paras. Scand. *279;* Thüm. Myc. Univ. *537, 1435;* Krieger, Schäd. Pilze *14, 15;* Briosi & Cavara, Funghi Parass. *131;* Rab. Fungi Eur. *1882;* Linhart, Fungi Hung. *237;* Allesch. & Schn. Fungi Bavar. *31;* Krieger, Fungi Sax. *60, 477;* Roum. Fungi Gall. *252, 434.*

28. **Gymnosporangium Mespili** (DC.)

Aecidium Mespili DC. Fl. Fr. **6**: 98. 1815.

Aecidium Cydoniae Lenorm.; Duby, Bot. Gall. **2**: 903. 1830.

Aecidium Cotoneasteris Körn. Hedwigia **16**: 24. 1877.

Roestelia Cydoniae Thüm. (Fungi Parenzo *278*) in Sacc. Syll. Fung. **7**: 834. 1888.

Gymnosporangium confusum Plowr. Brit. Ured. et Ustil. 232. 1889.

Tremella Mespili Arth. Proc. Ind. Acad. Sci. **1900**: 135. 1901.

Aecia hypophyllous and caulicolous, gregarious, cylindric, slender, 0.1–0.2 mm. in diameter by 1–2 mm. high; peridium soon becoming irregularly lacerate, often nearly to base, somewhat spreading; peridial cells seen in both side and face views, linear-rhomboid in side view, 15–24 by 65–80μ, lanceoate in face view, 17–21μ broad, outer wall thin, 1–1.5μ, smooth, inner and side walls rather thick 5–7μ, rather strongly rugose with ridges of varying length; aeciospores globoid, 19–22 by 19–26μ, wall rather thick, 2.5–3.5μ, cinnamon-brown, finely verrucose.

Telia caulicolous causing very slight fusiform enlargements, conic or laterally compressed, 5–8 mm. high, dark chestnut-brown; teliospores 2-celled, ellipsoid, 19–26 by 35–48μ, mostly not constricted at the septum, usually rounded at the apex and narrowed below, wall

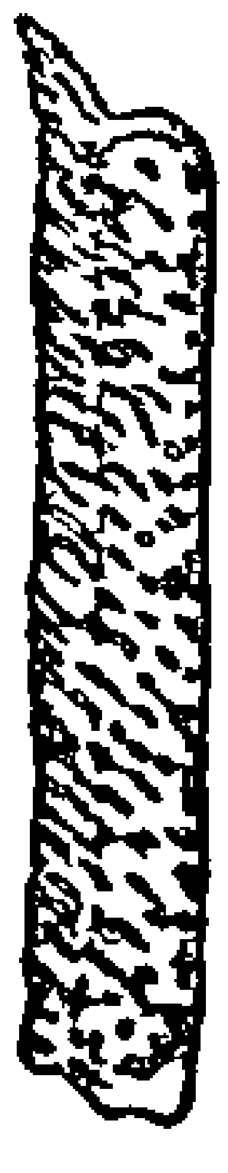

FIG. 24. *G. Mespili.*

cinnamon- to chestnut-brown, 1.5–3μ thick; pores 2 in each cell, near the septum.

HOST PLANTS:

For the aecia: *Cotoneaster tomentosa* Lindl., *C. vulgaris* Lindl., *Cydonia vulgaris* (L.) Pers., *Crataegus orientalis* Lindl., *C. oxyacantha* L., *C. grandiflora* Koch., *C. pinnatifida* Bunge, *C. tanacetifolia* Pers., *C. monogyna* Jacq., *Mespilus germanica* L., *Pyrus communis* L.,

For the telia: *Juniperus Sabina* L., *J. virginiana* L.

TYPE LOCALITY: Brussels, Belgium, on *Mespilus germanica.*

DISTRIBUTION: Europe and Central Asia.

ILLUSTRATIONS: Beitr. Krypt. Schweiz **2**^{2}: *f. 276;* Hedwigia **34**: 3, *f. 5;* Tubeuf, Pflanzenkr. *f. 207–213.*

EXSICCATI: Sydow, Ured. *134, 148, 149, 199, 292, 293, 294, 295, 839, 892, 893, 947, 2046, 2047;* Krieger, Fungi Sax. *361;* Sydow, Myc. Mar. *1429, 1703, 1904, 2648, 2649, 2921, 2922, 3812, 4125, 4229;* Roum. Fungi Gall. *3419, 3863;* Thüm. Myc. Univ. *1429;* Rab. Fungi Eur. *1985;* Briosi & Cavara, Funghi Paras. *288, 319.*

29. **Gymnosporangium transformans** (Ellis)

Roestelia transformans Ellis; Peck. Bull. Torrey Club **5**: 3. 1874.
Aecidium transformans Pazschke, in Rab. Fungi Eur. *4238.* 1901.

Aecia hypophyllous, caulicolous, and fruiticolous, occasionally solitary, usually gregarious, sometimes few together but more often aggregated in large groups, borne in gall-like, frustum-shaped protuberances (1–2 mm. high) of a reddish brown color which are more or less consolidated at the bases when in groups, at first cylindrical, 2–2.5 mm. high by 0.2–0.4 mm. in diameter; peridium soon becoming finely fimbriate to base, partially dropping away, remainder spreading and twisted; peridial cells usually seen only in side view, very long and narrow, becoming curved or even coiled when wet, 12–18μ thick by 150–300μ or more long (shorter toward apex of peridium), outer wall 2–3 μ thick, smooth, inner wall 4–6μ thick, rather coarsely verrucose, side walls verrucose on inner half with roundish or somewhat irregular papillae; aeciospores globose, small, 18–22μ in diameter, wall light cinnamon-brown, 1.5–2.5μ thick, rather finely verrucose.

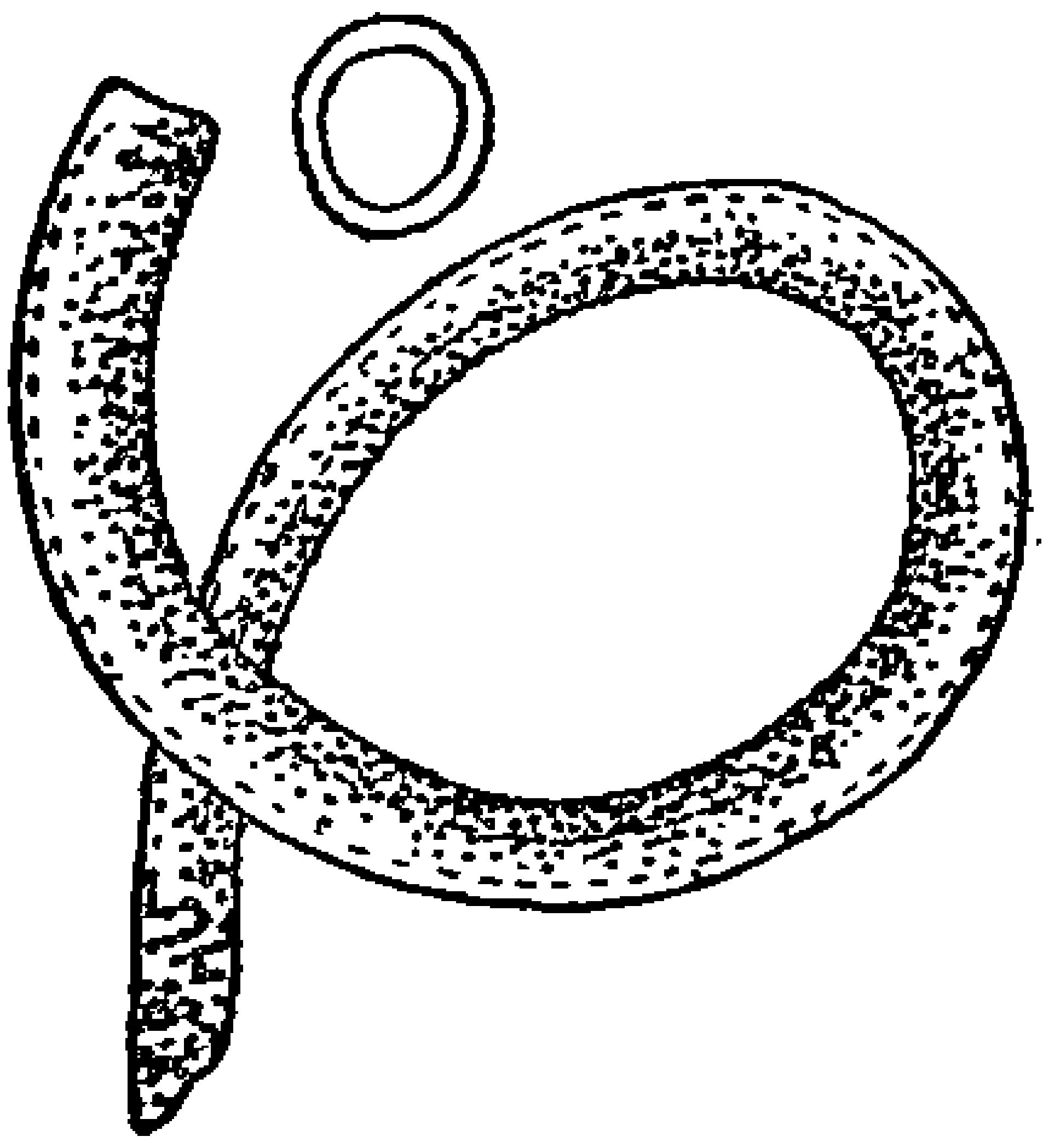

FIG. 25. *G. transformans.*

Telia unknown.

HOST PLANTS:

For the aecia: *Aronia arbutifolia* (L. f.) Ell. (*Pyrus arbutifolia* L. f.).

For the telia: unknown.

TYPE LOCALITY: Newfield, N. J., on *Pyrus arbutifolia.*

DISTRIBUTION: Small area along the Atlantic coast from Massachusetts to New Jersey.

ILLUSTRATION: Bot. Gaz. **49**: *pl. 21, f. 7.*

EXSICCATI: Ellis, N. Am. Fungi *1088;* Seym. & Earle, Econ. Fungi *247, 247a;* Roum. Fungi Sel. *4533;* Thüm. Myc. Univ. *1029;* Rab.-Paz. Fungi Eur. *4238.*

30. GYMNOSPORANGIUM CLAVARIAEFORME (Jacq.) DC. Fl. Fr. **2**: 217. 1805

Tremella clavariaeforme Jacq. Collectan. **2**: 174. 1788.
Tremella ligularis Bull. Herb. Fr. pl. 427. 1788.
Tremella digitata Vill. Hist. Pl. Dauph. **3**: 1007. 1789.
Aecidium laceratum Sow. Engl. Fungi 318. 1801.
Aecidium Oxyacanthae Pers. Syn. Fung. 206. 1801.
Cyglides laceratum Chev. Fl. Env. Paris **1**: 384. 1826.
Podisoma ligulatum Chev. Fl. Env. Paris **1**: 423. 1826.
Tremella juniperina Wahl. Fl. Suec. 994. 1826.
Podisoma clavariaeforme Duby, Bot. Gall. **2**: 881. 1830.
Podisoma Juniperi-communis Fries, Syst. Myc. **3**: 508. 1832.
Roestelia lacerata Fries, Sum. Veg. Scand. **2**: 510. 1849.
Roestelia carpophila Bagnis, Flora **63**: 317. 1880.
Roestelia lacerata x Thaxter, Proc. Amer. Acad. **22**: 266. 1887.
Puccinia penicillata Kuntze, Rev. Gen. Pl. **3**: 508. 1898.
Gymnosporangium gracile Pat. Bull. Soc. Myc. Fr. **18**: 46. 1902.
Gymnosporangium Oxycedri Bres. Broteria **2**: 88. 1903.
Aecidium clavariaeforme Arth. Résult. Sci. Congr. Bot. Vienne 343. 1905.

Aecia hypophyllous, fruiticolous, and caulicolous, usually crowded in small groups 2–3 mm. across on the leaf blades, sometimes in larger groups on the veins, petioles, and twigs, often densely aggregated on the fruits and occupying part or all of the surface, cylindric, 0.7–1.5 mm. high by 0.3–0.5 mm. in diameter; peridium soon becoming lacerate, usually to base, erect or spreading; peridial cells long and narrow, often becoming curved when wet, linear in face view, 18–30×80–130μ, linear or linear-oblong in side view, 15–25μ thick, outer wall 1–2μ thick, smooth, inner wall and side walls 5–7μ thick, rather coarsely verrucose with roundish or irregular papillae of varying sizes; aeciospores globoid, 21–27×25–30μ, wall light cinnamon-brown, 2.5–3.5μ thick, moderately verrucose.

Telia caulicolous, appearing on long fusiform swellings of various sized branches, numerous, scattered or sometimes aggregated, cylindric, or slightly compressed, 5–10 mm. long by 0.8–1.5 mm. in diameter, acutish or sometimes forked at the apex, brownish yellow; teliospores 2-celled, lanceolate, 13–20×50–80μ, occasionally longer, rounded or narrowed above, usually narrowed below, very slightly or not at all constricted at the septum, wall golden-yellow, thin, about 1μ; pores 2 in each cell, near the septum.

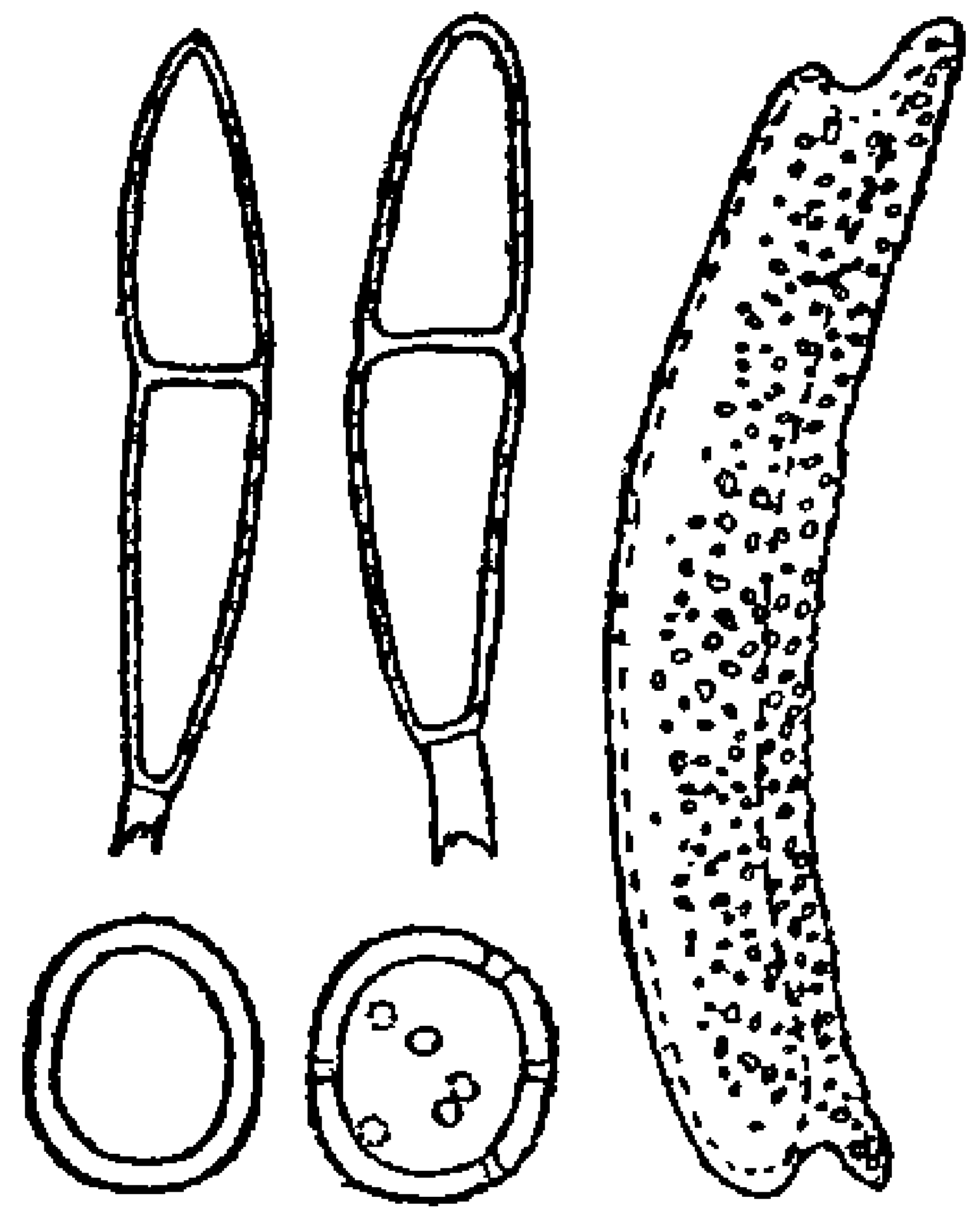

Fig. 26. *G. clavariaeforme.*

Host plants:

For the aecia: *Amelanchier alnifolia* Nutt., *A. canadensis* (L.) Medic., *A. intermedia* Spach., *A. oblongifolia* (Torr. & Gray) Roem., *A. oreophila* A. Nels., *A. polycarpa* Greene, *A. pumila* Nutt., *Aronia arbutifolia* (L.) Medic. (*Pyrus arbutifolia* L.), *Cotoneaster vulgaris* (L.) Pers., *Crataegus monogyna* Jacq., *C. nigra* Waldsb. & Kit., *C. oxyacantha* L., *C. pyracantha* Pers., *C. tanacetifolia* Pers., *Cydonia vulgaris* (L.) Pers., *Pyrus communis* L.

For the telia: *Juniperus communis* L., *J. oxycedrus* L., *J. sibirica* Burgsd. (*J. nana* Willd.).

Type locality: Corinthia, on *Juniperus communis.*

Distribution: Maine and Delaware west to Wisconsin and northeastern Iowa, and in Wyoming and Colorado; and in Europe.

Illustrations: Beitr. Krypt. Schweiz. **2**^{2}: *f. 275;* Hedwigia **34**: *3, f. 3;* Grev. Crypt. Fl. **4**: *pl. 209;* Bot. Gaz. **49**: *pl. 21, f. 6.*

Exsiccati: Ellis & Ev. Fungi Columb. *56;* Ellis, N. Am. Fungi *273;* Seym. & Earle, Econ. Fungi *241, 242a, b, c;* Syd. Ured. *134, 1036, 1692;* Sydow. Myc. Mar. *830;* Briosi & Cavara, Funghi Paras. *39;* Krieger, Fungi Sax. *361, 362;* Linhart, Fungi Hung. *332;* Rab. Fungi Eur. *2197;* Sacc. Myc. Ital. *256, 921;* Thüm. Myc. Univ. *1036, 1326;* Cooke, Fungi Brit. *2, 125;* Roum. Fungi Gall. *749, 1263, 2248;* Desm. Pl. Crypt. *1546;* Allesch. & Schn. Fungi Bavar. *32;* Vesterg. Microm. Rar. Sel. *756.*

31. **Gymnosporangium Yamadae** Miyabe (Bot. Mag. Tokyo **17**^{2}: 34, hyponym. 1903), sp. nov.

Aecia hypophyllous, in groups 2–3 mm. across on thickened discolored spots, tubular at first, 0.1–0.3 mm. in diam. by 1–3 mm. high; peridium becoming lacerate or fimbriate to base, spreading; peridial cells linear-rhomboid in side view, 18–24×55–95μ, outer wall thin, about 1μ, smooth, inner and side walls medium thin, 3–4μ, moderately verruculose with small, mostly oval papillae; aeciospores broadly ellipsoid or globoid, 17–21 ×21–26μ, wall chestnut-brown, 1.5–2.5μ thick, finely verrucose.

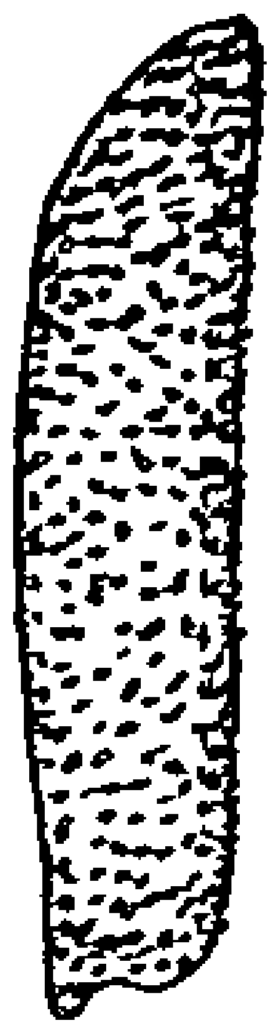

FIG. 27. *G. Yamadae.*

Telia unknown.

HOST PLANTS:

For the aecia: *Malus Malus* (L.) Britt. (*Pyrus Malus* L.), *M. spectabilis* (Ait.) Borkh. (*Pyrus spectabilis* Ait.), *M. Toringo* Sieb. (*Pyrus Toringo* Koch.).

For the telia: unknown.

Type collected at Tokyo, Japan, on *Pyrus spectabilis*, June 23, 1904, *N. Nambu.*

DISTRIBUTION: Known only from type locality.

32. GYMNOSPORANGIUM ELLISII (Berk.) Farlow, in Ellis, N. Am. Fungi *271.* 1879

Podisoma Ellisii Berk. Grevillea **3**: 56. 1874.
Hamaspora Ellisii Körn. Hedwigia **16**: 23. 1877.
Phragmidium Ellisii De Toni, in Sacc. Syll. Fung. **7** : 750. 1888.
Tremella Ellisii Arth. Proc. Ind. Acad. Sci. **1900**: 135. 1901.

Aecia unknown.

Telia caulicolous, from a perennial mycelium which distorts the younger branches causing slight enlargements and usually dense fasciations, numerous, thickly scattered, often over considerable areas, cylindric, filiform, 3–6 mm. long. about 0.5–1 mm. in diameter, orange-colored ; teliospores 2–5-celled, linear-fusiform, 9–16×85–170μ, not constricted at the septa, wall pale yellow, thin about 1μ; pores 2 in each cell (1 in the uppermost), apical.

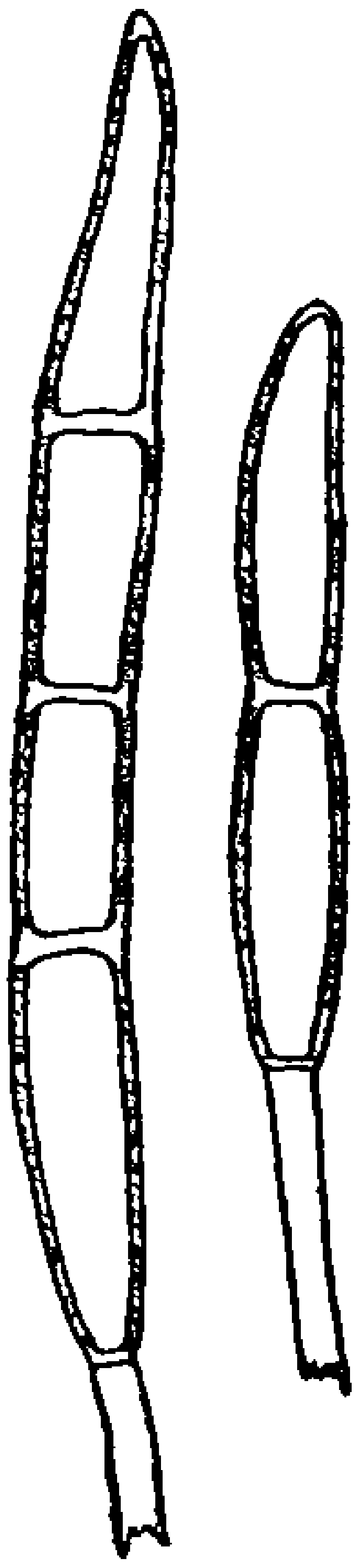

FIG. 28. *G. Ellisii.*

HOST PLANTS:

For the aecia: unknown.

For the telia: *Chamaecyparis thyoides* (L.) B.S.P. (*Cupressus thyoides* L., *Chamaecyparis sphaeroidea* Spach.).

TYPE LOCALITY: Newfield, N. J., on living white cedar [*Chamaecyparis thyoides*].

DISTRIBUTION: Along the Atlantic coast from Massachusetts to Delaware, also in northern Florida and southern Alabama.

ILLUSTRATIONS: Farlow, Anniv. Mem. Boston Soc. Nat. Hist. *pl. 2, f. 13–17.*

EXSICCATI: Rab.-Wint. Fungi Eur. *2920;* Thüm. Myc. Univ. *1936;* Roum. Fungi Sel. *4921;* Seym. & Earle, Econ. Fungi *246;* Ellis & Ev. Fungi Columb. *55;* Ellis, N. Am. Fungi *271.*

33. GYMNOSPORANGIUM BETHELI Kern, Bull. Torrey Club **34**: 459. 1907

Roestelia Betheli Kern, Bull. Torrey Club **34**: 461. 1907.

Aecia fruiticolous and hypophyllous, densely crowded, usually occupying only part of the surface of the fruits, in small groups on the leaf blades, cylindric, 0.2–0.3 mm. in diameter, 3–8 mm. high; peridium becoming finely lacerate above, often nearly to base, spreading; peridial cells long and narrow, curving somewhat when wet, broadly lanceolate in face view, 20–25×60–90μ, linear in side view, 13–20μ thick, outer wall 1–1.5μ thick, smooth, inner and side walls 4–6μ thick, rugose with closely set linear ridges and a few interspersed elongate papillae; aeciospores globoid, 18–24×23–30μ, wall chestnut brown, 2.5–3μ thick, finely verrucose.

Telia caulicolous, appearing on irregular, elongated, gall-like knots usually breaking forth in succession along the branches and varying greatly in size and extent, unevenly disposed, wedge-shaped, 1–1.5 mm. broad by 1–3 mm. long at the base by 3–4 mm. high, chestnut-brown; teliospores 2-celled, ellipsoid, 17–25×37–53μ, rounded or somewhat narrowed above and below, slightly or not constricted at the septum, wall dark cinnamon-brown, 1–2μ thick; pores 2 in each cell, near the septum.

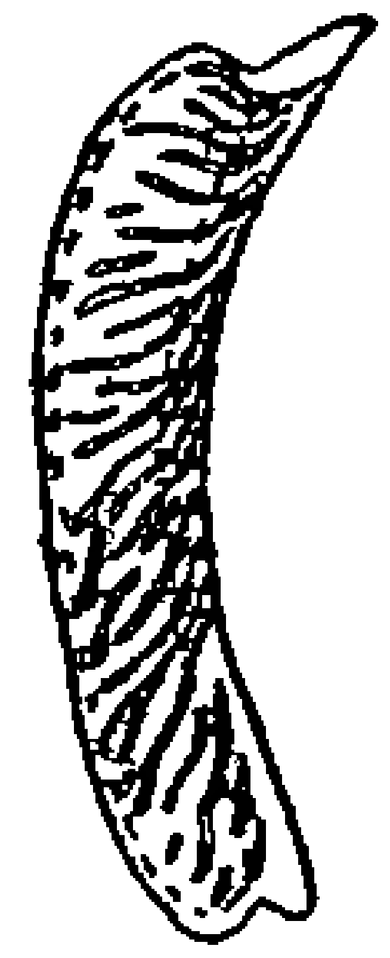

FIG. 29. *G. Betheli.*

HOST PLANTS:

For the aecia: *Crataegus coloradensis* A. Nels., *C. chrysocarpa* Ashe, *C. erythropoda* Ashe (*C. cerronis* A. Nels.), *C. Douglasii* Lindl., *C. occidentalis* Britton, *C. rivularis* Nutt., *C. saligna* Greene.

For the telia: *Juniperus scopulorum* Sarg. (*Sabina scopulorum* Rydb.

TYPE LOCALITY: Boulder, Colorado, on *Sabina scopulorum.*

DISTRIBUTION: Northeastern Washington and southeastern Oregon to Colorado.

ILLUSTRATION: Bot. Gaz. **49**: *pl. 21, f. 5.*

EXSICCATI: Barth. Fungi Columb. *2526, 2789, 2790.*

34. GYMNOSPORANGIUM GLOBOSUM Farlow, Anniv. Mem. Boston Soc. Nat. Hist. 34. 1880

Gymnosporangium fuscum globosum Farlow, Anniv. Mem. Boston Soc. Nat. Hist. 18. 1880.

Roestelia lacerata y, z, Thaxt. Proc. Am. Acad. **22**: 266. 1887.

Puccinia globosa Kuntze, Rev. Gen. Pl. **3**: 507. 1898.

Tremella globosa Arth. Proc. Ind. Acad. Sci. **1900**: 136. 1901.

Aecidium globosum Farlow, Bibl. Index **1**: 49. 1905.

Aecia chiefly hypophyllous, crowded in irregular or rarely annular groups 2–7 mm. across, cylindric, 1.5–3 mm. high by 0.1–0.2 mm. in diameter; peridium soon splitting in the upper part, becoming reticulate half way to base; peridial cells seen in both face and side views, broadly lanceolate in face view, 15–23×60–90μ, linear-rhomboid in side view, 13–19μ thick, outer wall about 1.5μ thick, smooth, inner and side walls 3–5μ thick, rather densely rugose with ridge-like papillae of varying length; aeciospores globoid or broadly ellipsoid, 15–19×18–25μ, wall light chestnut-brown, 1.5–2μ thick, finely verrucose.

Telia caulicolous, appearing on irregular globoid gall-like excrescences 3–25 mm. in diameter, unevenly disposed, often separated by the scars of the sori of previous seasons, tongue- or wedge-shaped, 1.5–3 mm. broad by 2–5 mm. long at the base by 6–12 mm. high, chestnut-brown; teliospores 2-celled, ellipsoid, 16–21×37–48μ, somewhat narrowed above and below, slightly constricted at the septum, wall pale cinnamon-brown, 1–2μ thick; pores 2 in each cell, near the septum.

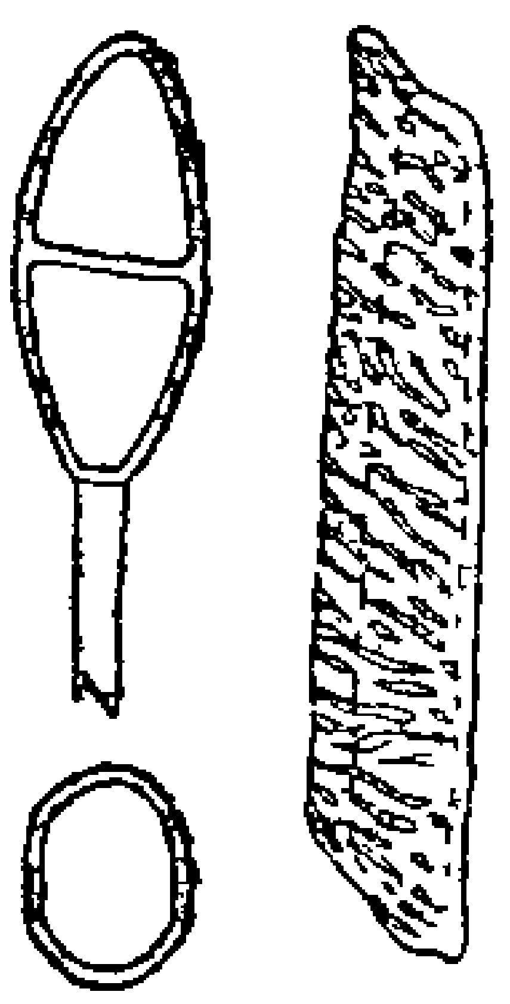

FIG. 30. *G. globosum.*

HOST PLANTS:

For the aecia: *Crataegus acutiloba* Sarg., *C. ancisa* Beadle, *C. anomala* Sarg., *C. apposita Bissellii* Egg., *C. arcuata* Ashe, *C. asperifolia* Sarg., *C. Biltmoreana* Beadle, *C. Boyntoni* Beadle, *C. Brainerdi* Sarg., *C. Buckleyi* Beadle, *C. Champlainensis* Sarg., *C. Chapmani* Ashe, *C. coccinea* L. (*C. modesta* Sarg.), *C. coccinoides* Ashe, *C. coccinoides dilitata* (Sarg.)

Eggl., *C. collina* Chapm., *C. colorata* Sarg., *C. conjuncta* Sarg., *C. conspicua* Sarg., *C. consueta* Sarg., *C. corusca* Sarg., *C. Crus-galli* L., *C. cyclophylla* Sarg., *C. decorata* Sarg., *C. delecta* Sarg., *C. delectabilis* Sarg., *C. delucida* Sarg., *C. demissa* Sarg., *C. dilitata* Sarg., *C. disjuncta* Sarg., *C. dispar* Beadle, *C. dispessa* Ashe (*C. pyriformis* Britton), *C. dissimilis* Sarg., *C. dissona* Sarg., *C. dumetosa* Sarg., *C. Eamesii* Sarg., *C. Edsoni* Sarg., *C. Egglestoni* Sarg., *C. Engelmani* Sarg., *C. festiva* Sarg., *C. Forbesae* Sarg., *C. fretalis* Sarg., *C. genialis* Sarg., *C. glaucophylla* Sarg., *C. harbisoni* Beadle, *C. Holmesianna* Ashe (*C. tenuifolia* Britton), *C. lasiantha* Sarg., *C. macilenta* Beadle, *C. macracantha* Lodd., *C. macracantha succulenta* (Schrad.) Eggl., *C. margaretta* Ashe, *C. McGeeae* Ashe, *C. membranacea* Sarg., *C. Mohri* Beadle, *C. mollis* (Torr. & Gray) Scheele, *C. Neo-Londonensis* Sarg., *C. Peckietta* Sarg., *C. pentandra* Sarg., *C. Pequotorum* Sarg., *C. pertomentosa* Ashe, *C. Phaenopyrum* (L. f.) Medic. (*C. cordata* Ait.), *C. pinguis* Sarg., *C. pisifera* Sarg., *C. polita Tatnalliana* (Sarg.) Egg., *C. praecox* Sarg., *C. Pringlei* Sarg., *C. pruinosa* (Wendl.) C. Koch., *C. pruinosa latisephala* (Ashe) Eggl. (*C. cognata* Sarg., *C. latisephala* Ashe), *C. punctata* Jacq., *C. Quinebangensis* Sarg., *C. Reverchoni* Sarg., *C. rhombifolia* Sarg., *C. roanensis* Ashe (*C. ascendens* Sarg.), *C. Robbinsiana* Sarg., *C. rotundifolia* Moench., *C. scabrida* Sarg., *C. Schweinitziana* Sarg., *C. submollis* Sarg., *C. tecta* Beadle, *C. tenella* Ashe, *C. tetrica* Beadle, *C. tomentosa* L., *C. Treleasii* Sarg., *Malus Malus* (L.) Britton, *Pyrus communis* L., *Sorbus americana* Marsh.

For the telia: *Juniperus barbadensis* L., *J. virginiana* L.

TYPE LOCALITY: Massachusetts, on *Juniperus virginiana.*

DISTRIBUTION: Maine west to southeastern South Dakota and south to northern Florida and Texas.

ILLUSTRATIONS: Farlow, Anniv. Mem. Boston Soc. Nat. Hist. *pl. 1, f. 7–11;* Bull. Iowa Exper. Sta. 84: *f. 3;* E. & P. Nat. Pflanzenfam. **1**^{1**}: *f. 34, A;* Hedwigia **34**: 3, *f. 6;* Bot. Gaz. **49**: *pl. 21, f. 4.*

EXSICCATI: Ellis & Ev. Fungi Columb. *758, 2028;* Ellis & Ev. N. Am. Fungi *2997, 2998;* Ellis, N. Am. Fungi *1478;* Thüm. Myc. Univ. *2139;* Sydow, Ured. *296, 1434, 2048;* Rab.-Wint.-Paz.

Fungi Eur. *4013;* Seym. & Earle, Econ. Fungi *230a, b, 231a, b, c, 232a, b, 233a, b;* Kellerm. Ohio Fungi *44;* Kellerm. & Sw. Kans. Fungi *2496;* Rav. Fungi Am. *481;* Shear, N. Y. Fungi *79, 123*.

35. **Gymnosporangium hyalinum** (Cooke)

Roestelia hyalina Cooke, Bull. Soc. Bot. France **24**: 314. 1877.

Aecidium hyalinum Farlow, Bibl. Index **1**: 55. 1905.

Aecia hypophyllous, gregarious, borne in small gall-like pyriform protuberances of a reddish brown color which are usually consolidated at their bases, cylindric, 2–5 mm. high by 0.2–0.3 mm. in diameter; peridium tardily rupturing with a few irregular slits along the sides, somewhat twisted but not spreading or recurved; peridial cells usually seen only in face view, lanceolate, 19–29×87–105μ, usually obtuse below and considerably narrowed above, walls smooth on all surfaces, inner and side walls 3–4μ thick, outer wall 12–16μ; aeciospores globoid, 19–26μ in diameter, wall light cinnamon-brown, 2–3μ thick, very moderately verrucose.

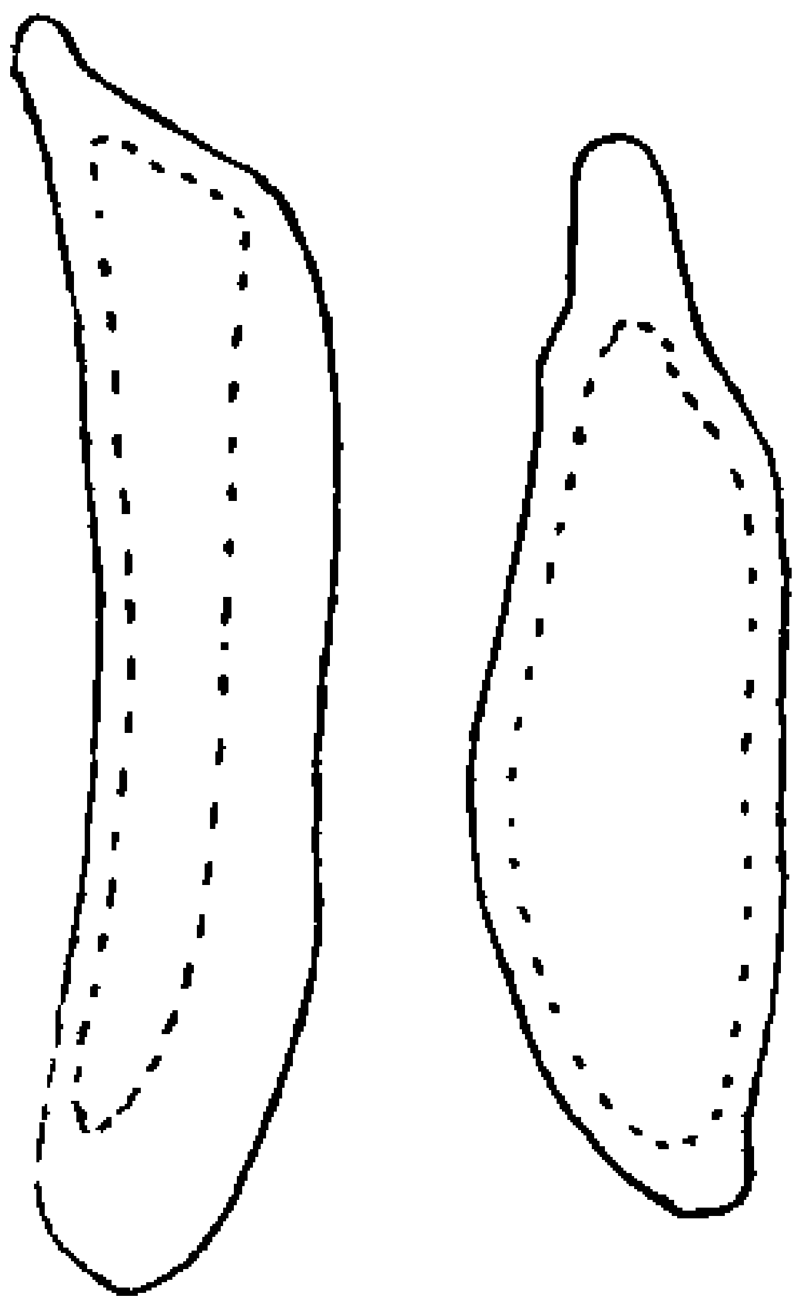

FIG. 31. *G. hyalinum.*

Telia unknown.

HOST PLANTS:

For the aecia: *Crataegus clara* Beadle, *C. dispar* Beadle, *C. egens* Beadle, *C. egregia* Beadle, *C. Michauxii* Pers., *C. munda* Beadle, *C. pexa* Beadle, *C. quasita* Beadle, *C. viridis* L., *C. visenda* Beadle.

TYPE LOCALITY: South Carolina on *Crataegus sp.*

DISTRIBUTION: Atlantic coast from North Carolina south to northern Florida.

ILLUSTRATION: Bot. Gaz. **49**: *pl. 22, f. 11.*

EXSICCATI: Rav. Fungi Am. 37.

36. GYMNOSPORANGIUM NELSONI Arth. Bull. Torrey Club **28**: 665. 1901.

Roestelia Nelsoni Arth. Bull. Torrey Club **28**: 665. 1901.

Aecidium Nelsoni Farl. Bibl. Index **1**: 68. 1905.

Gymnosporangium durum Kern, Bull. Torrey Club **34**: 460. 1907.

Aecia hypophyllous and fruiticolous, usually in small groups 1–2 mm. across, cylindric, 2–4 mm. high by 0.2–0.3 mm. in diam.;

peridium whitish, dehiscent at apex and also rupturing more or less along the sides; peridial cells seen in both face and side views, broadly lanceolate in face view, 18–35×75–115μ, linear-rhomboid in side view, 16–35μ thick, outer wall rather thin, 1.5–2μ, smooth, inner and side walls rather thick, 7–12μ, evenly and densely verruculose; aeciospores globoid, 19–26×21–29μ, wall chestnut-brown, 2–3μ thick, finely verrucose.

Telia caulicolous, appearing on firm, woody, globose galls 0.5–5 cm. in diameter, unevenly disposed, densely aggregated or often separated by the scars of the sori of previous seasons, irregularly flattened, about 1–1.5 mm. broad by 1–5 mm. long at the base by 3–4 mm. high, often confluent, light chestnut-brown; teliospores 2-celled, narrowly ellipsoid, 18–26×50–65μ, narrowed at both ends, slightly constricted at the septum; wall pale cinnamon-brown, 1–1.5μ thick; pores 2 in each cell, near the septum.

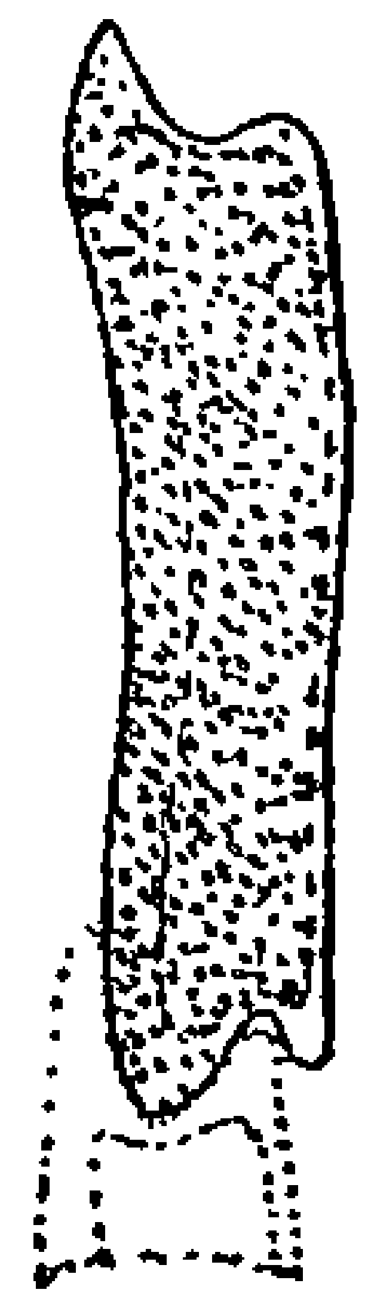

FIG. 32. *G. Nelsoni.*

HOST PLANTS:

For the aecia: *Cydonia vulgaris* (L.) Pers., *Amelanchier alnifolia* Nutt., *A. elliptica* A. Nels., *A. oreophila* A. Nels., *A. polycarpa* Greene, *A. pumila* Nutt., *Peraphyllum ramosissimum* Nutt., *Pyrus communis* L.

For the telia: *Juniperus monosperma* (Engelm.) Sarg. *J. scopulorum* Sarg., *J. utahensis* (Engelm.) Lemm.

TYPE LOCALITY: Laramie Hills, Wyoming, on *Juniperus scopulorum.*

DISTRIBUTION: Alberta south to Colorado and Arizona.

EXSICCATI: Ellis & Ev. Fungi Columb. *1676;* Garrett. Fungi Utah. *177.*

For explanation of the synonymy of this species see note under *G. juvenescens* (*No. 14*).

37. GYMNOSPORANGIUM CORNICULANS Kern, Mycologia **2**: 236. 1910

Aecia hypophyllous, crowded in irregular or sometimes annular groups 2–5 mm. across, on discolored hypertrophied spots, cylindric or horn-shaped, acutish at apex, 2–3.5 mm. high, 0.3–0.5 mm. in diameter; peridium not or only rarely rupturing at apex, very tardily dehiscent by longitudinal slits along the sides; peridial cells usually seen in face view, broadly lanceolate, 16–23×64–96μ, rhomboid in side view, 18–25μ thick, outer wall 1.5–2μ thick, smooth, inner and side walls rather thick, 5–7μ, moderately verrucose with oval or roundish papillae and a few delicate elongated papillae interspersed; aeciospores globoid, 20–36×23–32μ, wall dark cinnamon-brown, 3–4μ thick; very finely verrucose, appearing nearly smooth.

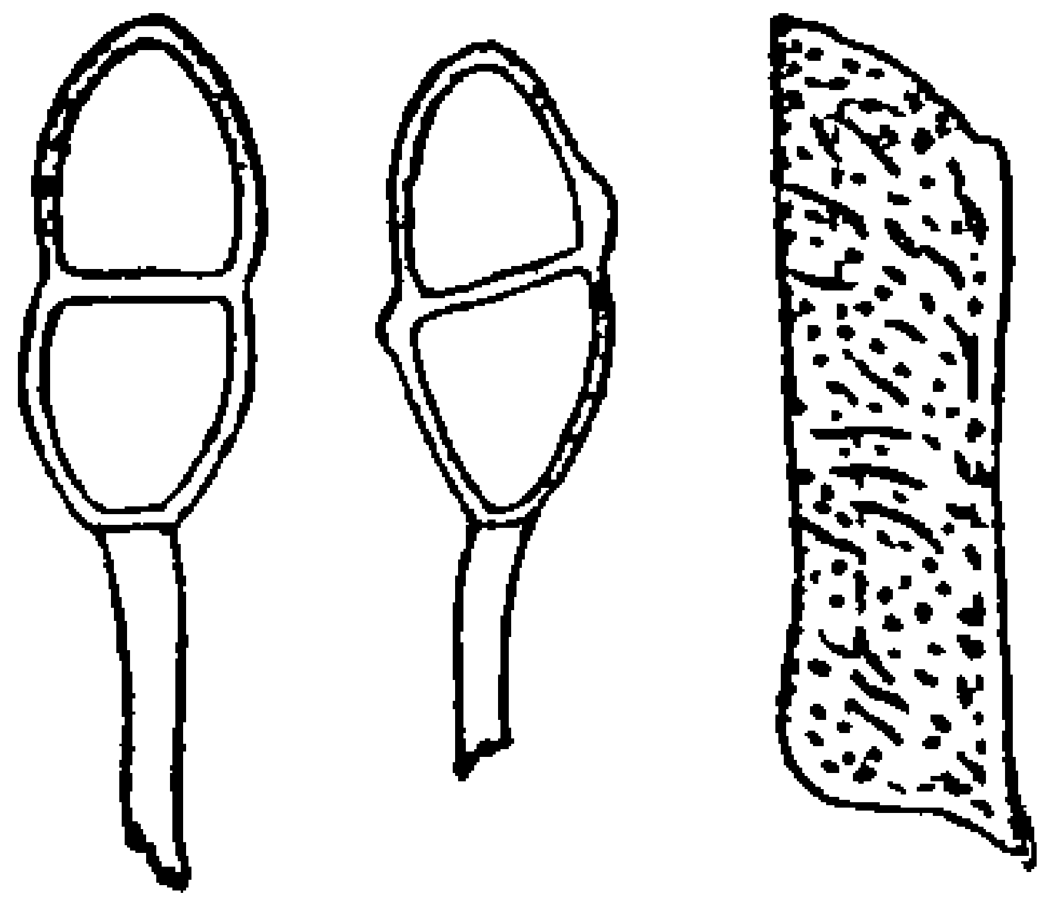

FIG. 33. *G. corniculans.*

Telia caulicolous, appearing on irregularly lobed gall-like excrescences, 2–15 mm. or more in diameter, unevenly disposed, often separated by the scars of the sori of previous seasons, conic or cylindric-acuminate, 1.5–2 mm. in diameter at base by 3–5 mm. high, dark chestnut-brown; teliospores 2-celled, ellipsoid, 18–21×35–50μ, usually rounded both above and below, slightly or not at all constricted at the septum, slightly enlarged near the septum in one or two places owing to the presence of hyaline thickenings over the germ-pores, wall light cinnamon-brown, thin, 1–1.5μ; hyaline thickenings about 1–1.5μ; pores 1–2 in each cell, near the septum.

HOST PLANTS:

For the aecia: *Amelanchier canadensis* (L.) Medic., *A. erecta* Blanch., *A. intermedia* Spach., *A. oblongifolia* (Torr. & Gray) Roem., *A. sanguinea* (Pursh) Lindley.

For the telia: *Juniperus horizontalis* Moench (*J. prostrata* Pers.), *J. virginiana* L.

TYPE LOCALITY: Leland, Mich., on *Juniperus horizontalis.*

DISTRIBUTION: From Vermont and Massachusetts west to northern Illinois and eastern Iowa.

EXSICCATI: Seym. & Earle, Econ. Fungi *248a, b;* Ellis & Ev. Fungi Columb. *1827*; Ellis & Ev. N. Am. Fungi *2715.*

38. GYMNOSPORANGIUM FLORIFORME Thaxt.; Kern, Bull. Torrey Club **35**: 503. 1908

Roestelia flaviformis Atkinson; Underw. & Earle, Bull. Ala. Exp. Sta. 80: 218, hyponym. 1897.

Gymnosporangium flaviformis Earle, Contr. U. S. Herb. **6**: 186, hyponym. 1901.

Aecidium flaviformis Farlow, Bibl. Index **1**: 44, hyponym. 1905.

Aecia hypophyllous, rather widely separated in oblong-annular groups 2–6 mm. across, on thickened discolored spots, at first cylindric, 1–1.5 mm. high by 0.2–0.5 mm. in diameter; peridium rupturing extremely early and becoming finely fimbriate to base, strongly revolute; peridial cells usually seen only in side view, long and narrow, 10–14×65–85μ, becoming somewhat curved when wet, outer wall 1.5–2μ thick, smooth, inner wall 4–5μ thick, rugose, side walls closely rugose with ridge-like markings extending nearly to outer side; aeciospores angular-ellipsoid, 18–23×23–29μ, wall chestnut-brown, 1.5–2.5μ thick; finely verrucose.

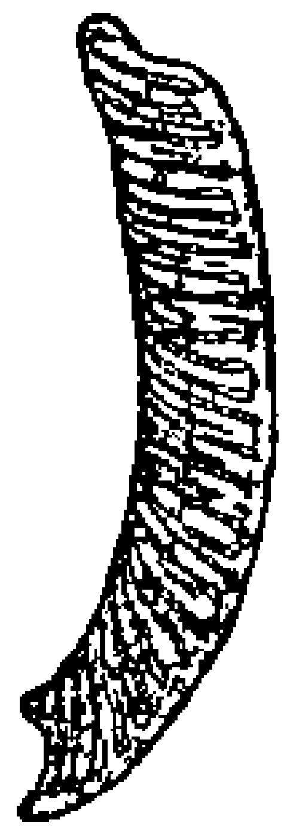
FIG. 34. *G. floriforme.*

Telia appearing on rather small, lobed, gall-like excrescences 3–10 mm. across, or occasionally on larger, globoid, or subreniform galls, usually numerous, rather evenly disposed, about 1–3 mm. apart, sometimes few in a ray-like arrangement at right angles to the short axis of the gall, conic or cylindric-acuminate, 1–1.5 mm. broad at base by 3–10 mm. long, chestnut-brown; teliospores 2-celled, narrowly ellipsoid, 15–19×39–50μ, rounded above and below, slightly or not constricted at the septum, wall pale cinnamon-brown, 1–1.5μ thick; pores 2 in each cell, near the septum.

HOST PLANTS:

For the aecia: *Crataegus spathulata* Michx.

For the telia: *Juniperus virginiana* L. (*Sabina virginiana* Antoine).

TYPE LOCALITY: Auburn, Lee County, Alabama, on *Sabina virginiana.*

DISTRIBUTION: South Carolina and northern Florida westward to Arkansas and eastern Texas.

ILLUSTRATION: Bot. Gaz. **49**: *pl. 21, f. 3.*

EXSICCATI: Sydow, Ured. *1194.*

39. GYMNOSPORANGIUM JUNIPERI-VIRGINIANAE Schw. Schr. Nat. Ges. Leipzig 1: 74. 1822

Gymnosporangium macropus Link, in Willd. Sp. Pl. **6**²: 128. 1825.
Gymnosporangium virginianum Spreng. Syst. Veg. **4**: 562. 1827.
Podisoma Juniperi-virginianae Fries, Syst. Myc. **3**: 507. 1832.
Caeoma (*Aecidium*) *pyratum* Schw. Trans. Am. Phil. Soc. II. **4**: 294. 1832.
Podisoma macropus Schw. Trans. Am. Phil. Soc. II. **4**: 307. 1832.
Aecidium pyratum Schw. Trans. Am. Phil. Soc. II. **4**: 309. 1832.
Roestelia penicillata Farlow, Ann. Mem. Boston Soc. Nat. Hist. 30. 1880. Not *R. penicillata* Fries. 1849.
Roestelia pyrata Thaxt. Proc. Amer. Acad. **22**: 269. 1886.
Puccinia macropus Kuntze, Rev. Gen. Pl. **3**: 507. 1898.
Puccinia Juniperi-virginianae Arth. Proc. Ind. Acad. Sci. **1898**: 186. 1899.

Tremella Juniperi-virginianae Arth. Proc. Ind. Acad. Sci. **1900**: 135. 1901.

Aecidium Juniperi-virginianae Arth. Résult. Sci. Congr. Bot. Vienne 343. 1905.

Aecia chiefly hypophyllous, usually in annular groups, on thickened discolored spots, at first cylindric, 0.1–0.4 mm. in diameter; peridium splitting extremely early becoming fimbriate to the base, strongly revolute; peridial cells usually seen only in side view, long and narrow, 10–16 by 65–100μ, becoming much curved when wet, inner and side walls rather sparsely rugose with ridges extending half way across the side walls; aeciospores globoid or broadly ellipsoid, 16–24 by 21–31μ, wall light chestnut-brown, 2–3μ thick, finely verrucose.

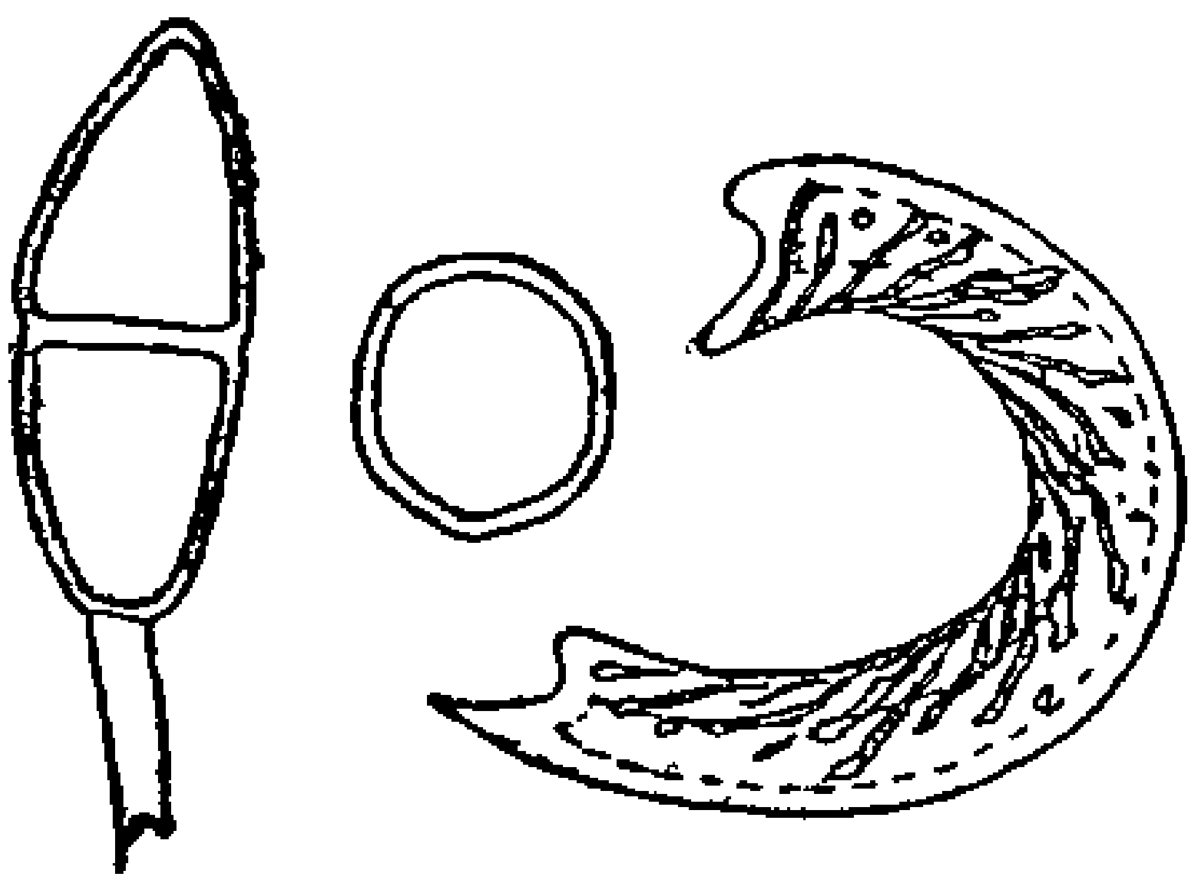

FIG. 35. *G. Juniperi-virginianae.*

Telia appearing on globoid or reniform galls 5–30 mm. or more in diameter, evenly disposed, cylindric or cylindric-acuminate, 1.5–3 mm. in diameter by 10–20 mm. long, golden-brown; teliospores 2-celled, rhombic-oval or narrowly ellipsoid, 15–21 by 42–65μ; slightly or not constricted at the septum, wall pale cinnamon-brown, thin, about 1μ; pedicel cylindric, 3–5μ in diameter; pores 2 in each cell near the septum.

HOST PLANTS:

For the aecia: *Malus angustifolia* (Ait.) Michx., *M. baccata* (L.) Desf., *M. coronaria* (L.) Mill., *M. ioensis* (Wood) Britton, *M. Malus* (L.) Britton.

For the telia: *Juniperus barbadensis* L., *J. virginiana* L.

TYPE LOCALITY: North Carolina, on *Juniperus virginiana.*

DISTRIBUTION: Massachusetts and Ontario west to S. Dakota, south to Texas and Florida.

ILLUSTRATIONS: Farlow, Anniv. Mem. Boston Soc. Nat. Hist. *pl. 1, f. 1–6;* Ann. Bot. **1**: *pl. 13;* Bull. Iowa Exp. Station 84, *f. 1, 2, 5c;* Hedwigia **34**: 3, *f. 8;* Bot. Gaz. **49**: *pl. 21, f. 2;* E. & P. Nat. Pflanzenfam. **1**^{1**}: *f. 34B;* Ann. Rep. Neb. Exp. Station **22**: *f. 1–12.*

EXSICCATI: Ellis & Ev. N. Am. Fungi *2713;* Ellis & Ev. Fungi Columb. *757, 1929, 2029, 2030;* Ellis, N. Am. Fungi *270, 1086a, b, 2713;* Kellerm. Ohio Fungi, *22;* Kellerm. & Sw. Kan. Fungi *19;* Carleton, Ured. Am. *39;* Rab.-Wint. Fungi Eur. *2921;* Rab.-Wint.-Paz. Fungi Eur. *4014;* Seym. & Earle, Econ. Fungi *227a, 228, 229, 229x, y;* Shear, N. Y. Fungi *317;* Sydow, Ured. *1195;* Thüm. Myc.

Univ. *148*, *732;* Rav. Fungi Am. *481;* Vesterg. Micr. Rar. Sel. *633;* Barth. Fungi Columb. *2626*, *3328;* Barth, N. Am. Ured. *107*.

40. GYMNOSPORANGIUM BERMUDIANUM (Farlow) Earle; Seym. & Earle, Econ. Fungi *249*. 1893

Aecidium bermudianum Farlow, Bot. Gaz. **12**: 206. 1887.

Tremella bermudiana Arth. Proc. Ind. Acad. Sci. **1900**: 136. 1901.

Aecia appearing on globoid or subreniform galls of reddish brown luster (6–12 mm. in diameter), cylindric, 0.8–1.5 mm. high by 0.1–0.3 in diameter; peridium fragile, soon becoming lacerate, often to base, spreading but not recurved; peridial cells narrowly obovate in face view, 18–25 × 50–75 μ linear-rhomboid in side view, 15–18 μ thick, outer wall thin, about 1.5 μ, smooth, inner wall thicker, 3–5 μ, moderately rugose with closely set ridge-like papillae of varying length; aeciospores globoid or polygonal, 16–19 × 19–39 μ, wall dark chestnut-brown, 2–2.5 μ thick, minutely verrucose.

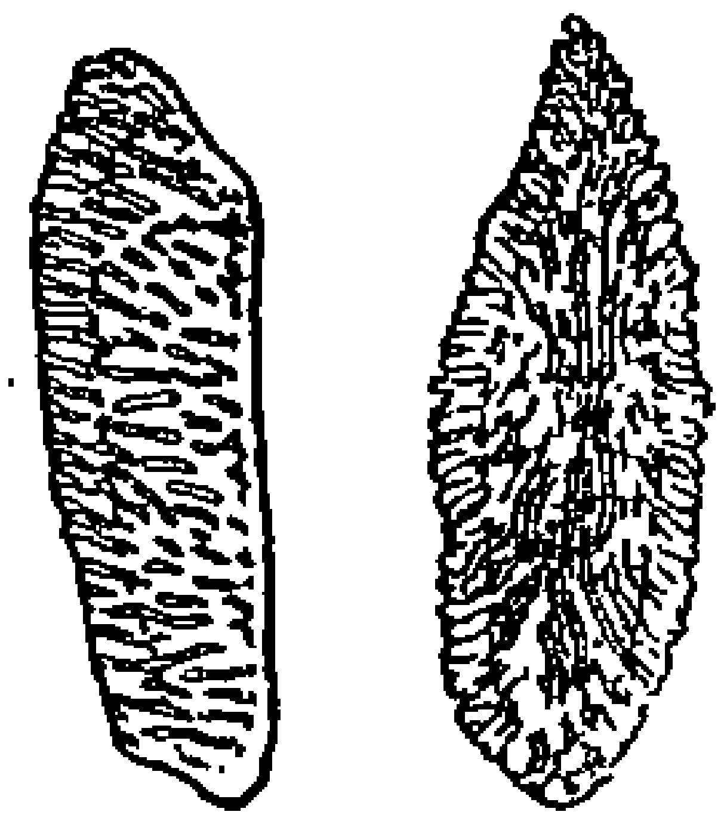
FIG. 36. *G. bermudianum.*

Telia following the aecia on the same galls, few, irregularly disposed, pulvinate, low, roundish, 0.4–0.7 mm. across, dark cinnamon-brown; teliospores 2-celled, ellipsoid, 18–25 × 34–50 μ, rounded or somewhat narrowed both above and below, slightly constricted at the septum, wall cinnamon-brown, thin, about 1 μ; pores 2 in each cell, near the septum.

HOST PLANTS:

For the aecia and telia: *Juniperus barbadensis* L. (*Sabina barbadensis* Small), *J. bermudiana* L. (*S. bermudiana* Antoine), *J. lucayana* Britton, *J. virginiana* L. (*S. virginiana* Antoine).

TYPE LOCALITY: Bermuda, on *Juniperus virginiana.*

DISTRIBUTION: Along the gulf coast from Mississippi to Florida, and in the Bermuda and Bahama Islands.

ILLUSTRATION: Bot. Gaz. **49**: *pl. 21*, *f. 1*.

EXSICCATI: Seym. & Earle, Econ. Fungi *249*, *250*.

EXCLUDED OR DOUBTFUL SPECIES

Gymnosporangium asiaticum Miyabe, Bot. Mag. **17**^{2}: 34, hyponym. 1903. On *Pyrus sinensis* Lindl. and *Cydonia vulgaris* (L.) Pers. Doubtful, the form on *P. sinensis* may be *G. japonicum.*

Gymnosporangium Sabinum Fries, Syst. Myc. **3**: 507. 1832. Not a *Gymnosporangium.*

Hamaspora longissima (Thüm.) Körn. Hedw. **16**: 23. 1877. A *Phragmidium.*

Podisoma foliicola Berk.; Smith, Eng. Flora **5**^{2}: 362. 1836. Not a rust but one of the Fungi Imperfecti referred to the genus *Hendersonia* by Fuckel.

Roestelia guaranitica De Toni, in Sacc. Syll. Fung. **7**: 833. (*Ceratitium guaraniticum* Speg. Anal. Soc. Ci. Argent. **17**: 126. 1884.) On *Salvia* and may belong to a *Puccinia.*

Roestelia interveniens Peck, Bull. Torrey Club **10**: 74. 1883. Doubtful, may belong to a *Puccinia.*

Roestelia phaeospora De Toni, in Sacc. Syll. Fung. **7**: 834. (*Ceratitium phaeosporum* Ces. Mycet. Born. 26. 1879.) On an unknown plant; may belong here but it is impossible to say from such incomplete information.

Roestelia polita Berk. Linn. Journ. **13**: 174. 1872. The aecial stage of an autoecious *Uromyces.*

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EXPLANATION OF ILLUSTRATIONS

TEXT-FIGURES

FIG. 1. Full explanation included with it.

FIGS. 2–36. The names are given under each figure. The drawings were outlined with the aid of a camera lucida at a uniform scale and were reduced equally in reproduction, representing approximately a magnification of 350 diameters. In all drawings of peridial cells the end which is uppermost is the upper end of the cell, or the end which is toward the apex of the peridium. In all peridial cells except those in figures 3 and 31 the inner wall is the thicker. In figures 8, 31, and 36 face views of peridial cells are given and in figure 5 is a cross section.

PLATE 151

(Frontispiece)—*Gymnosporangium Juniperi-virginianae.* The common "Cedar-apple."

PLATE 152

Fig. 37. (19) *G. cornutum* on *Sorbus aucuparia;* typical groups of epiphyllous pycnia, (K) pycniospore. After Oersted (1866^1 *pl. 4*).

Fig. 38. *G. Sorbi* on *Sorbus occidentalis;* aecia short, cupulate.

Fig. 39. *G. cornutum* on *Sorbus americana;* elongated aecia, the peridium retaining its tubular or cornute form after dehiscence.

Fig. 40. *G. corniculans* on *Amelanchier erecta;* elongated aecia, the peridium retaining its tubular or cornute form after dehiscence.

PLATE 153

Fig. 41. *G. germinale* on *Cydonia vulgaris;* elongated aecia, the peridium soon becoming deeply lacerate, erect or spreading. After Stewart.

Fig. 42. *G. Juniperi-virginianae* on *Malus Malus* (fruit); elongated aecia, the peridium soon becoming fimbriate and strongly revolute.

Fig. 43. *G. bermudianum* on *Juniperus barbadensis;* autoecious, aecia elongated, appearing on galls like the telia.

PLATE 154

Fig. 44. *G. Blasdaleanum* on *Heyderia decurrens;* telia foliicolous, not causing hypertrophy, pulvinate.

Fig. 45. *G. inconspicuum* on *Juniperus utahensis;* telia between scale-like leaves with little or no hypertrophy.

Fig. 46. *G. Davisii* on *Juniperus sibirica;* telia epiphyllous, hemispheric.

Fig. 47. *G. cornutum* on *J. communis;* showing some foliicolous telia, they are usually caulicolous, see *Pl. 160, f. 62, 63.* After Oersted (1866^1 *pl. 3. f. 1*).

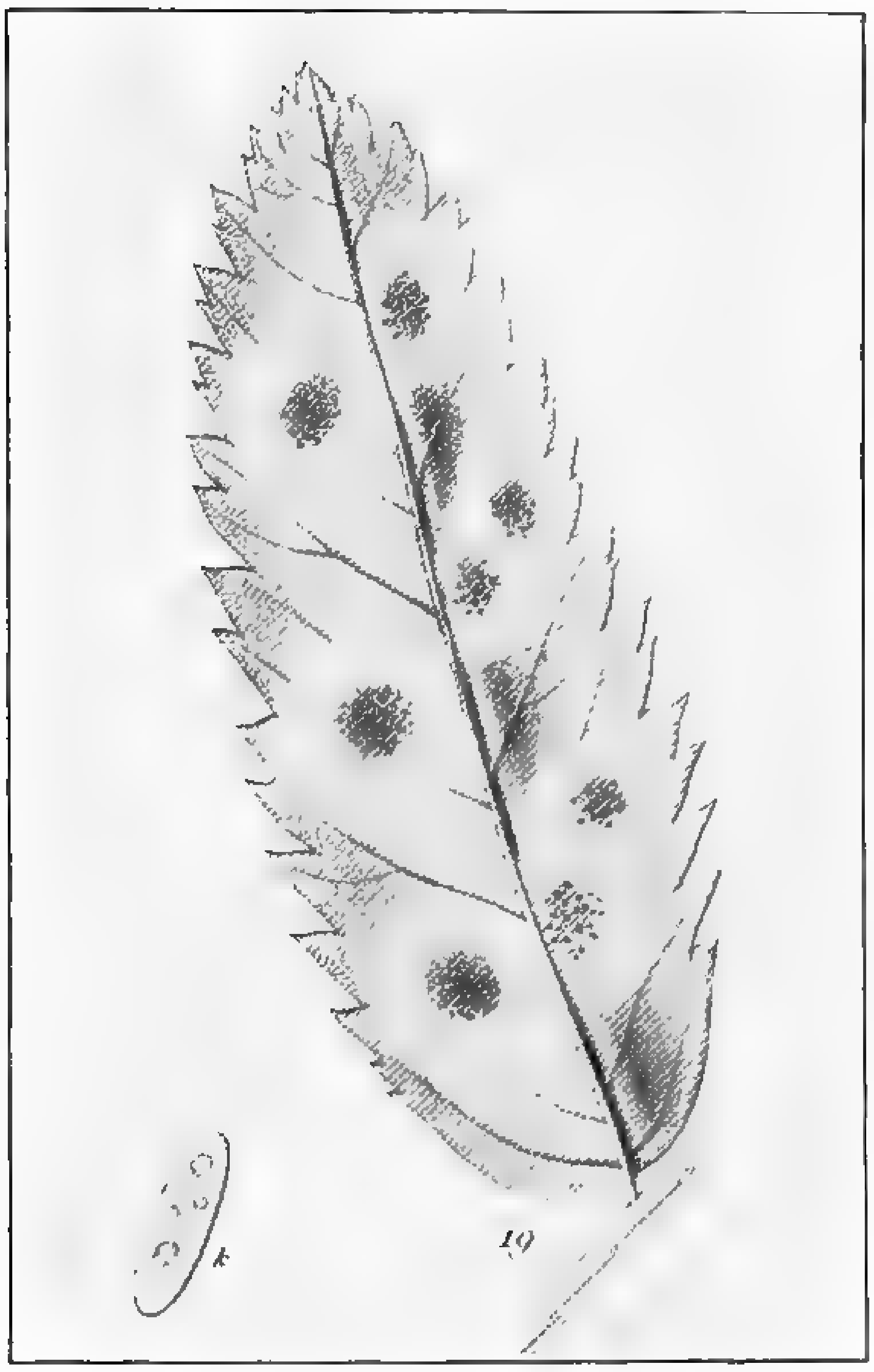

FIG. 37. G. CORNUTUM (AFTER OERSTED)

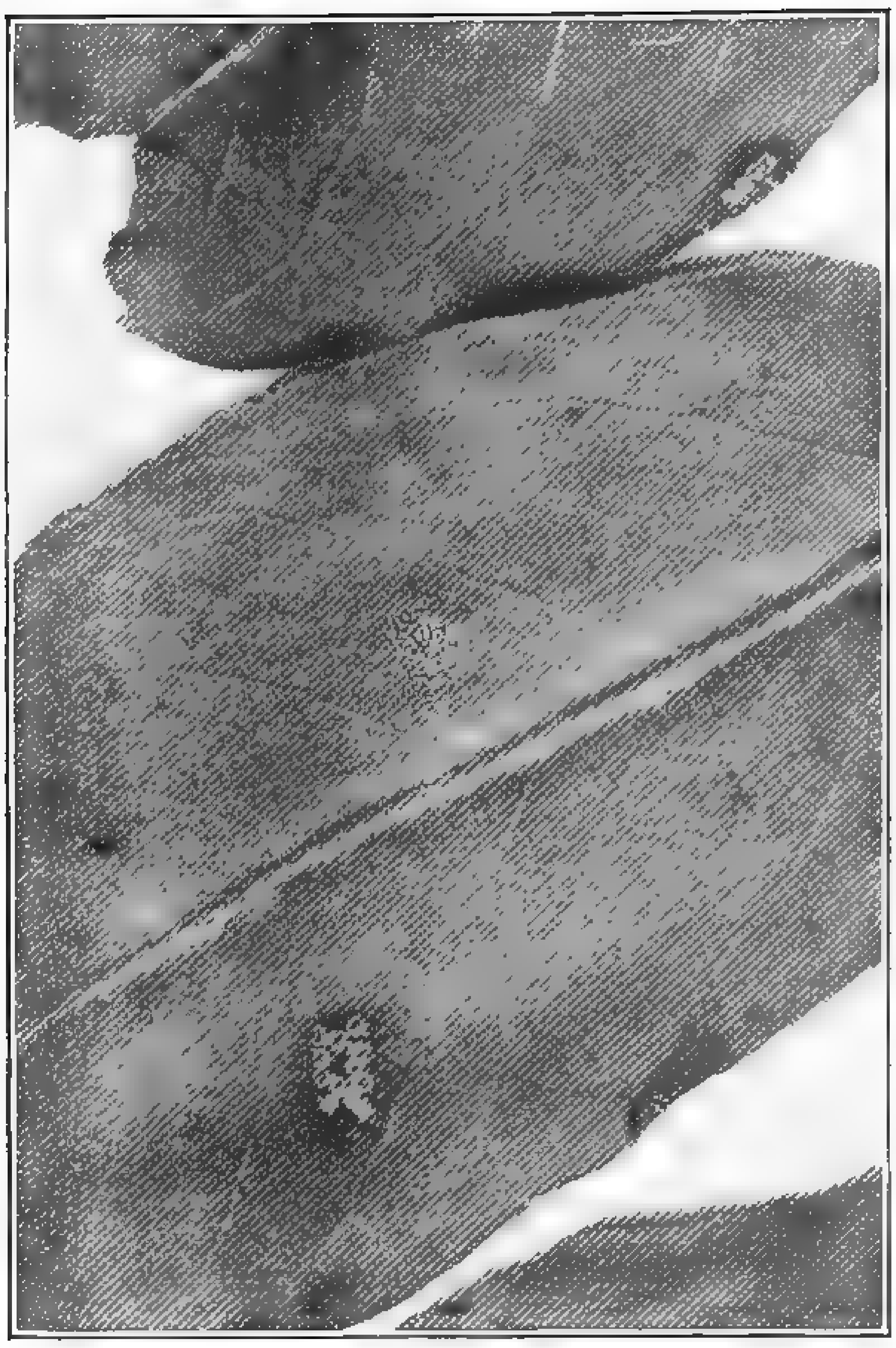

FIG. 38. G. SORBI (ENLARGED)

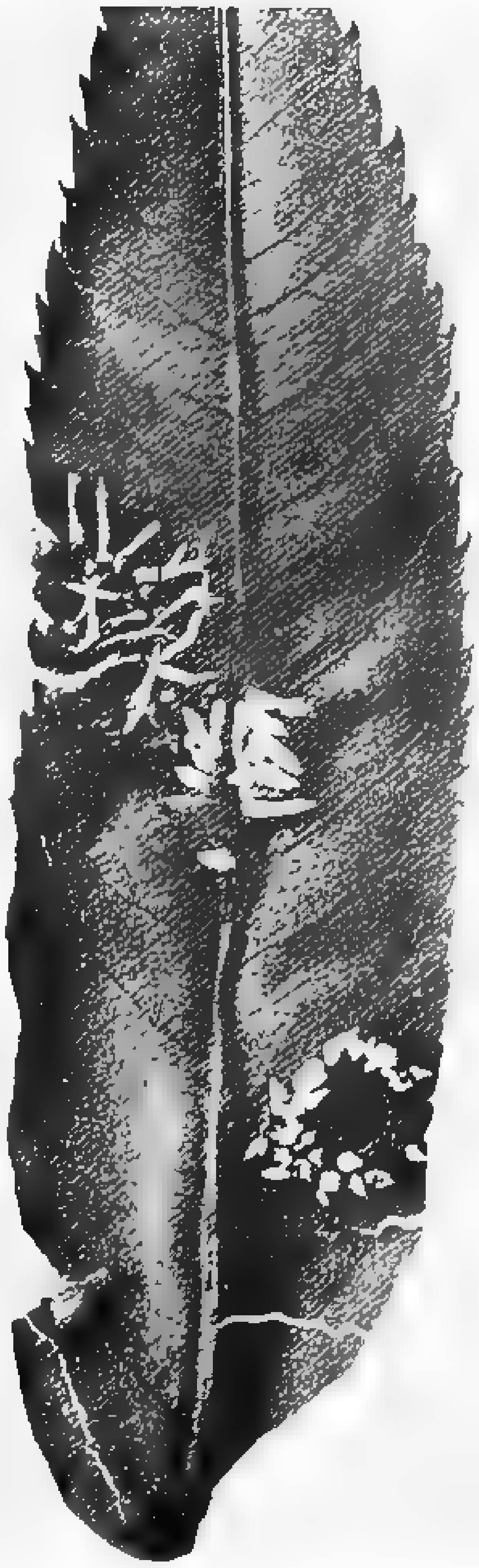

FIG. 39. G. CORNUTUM

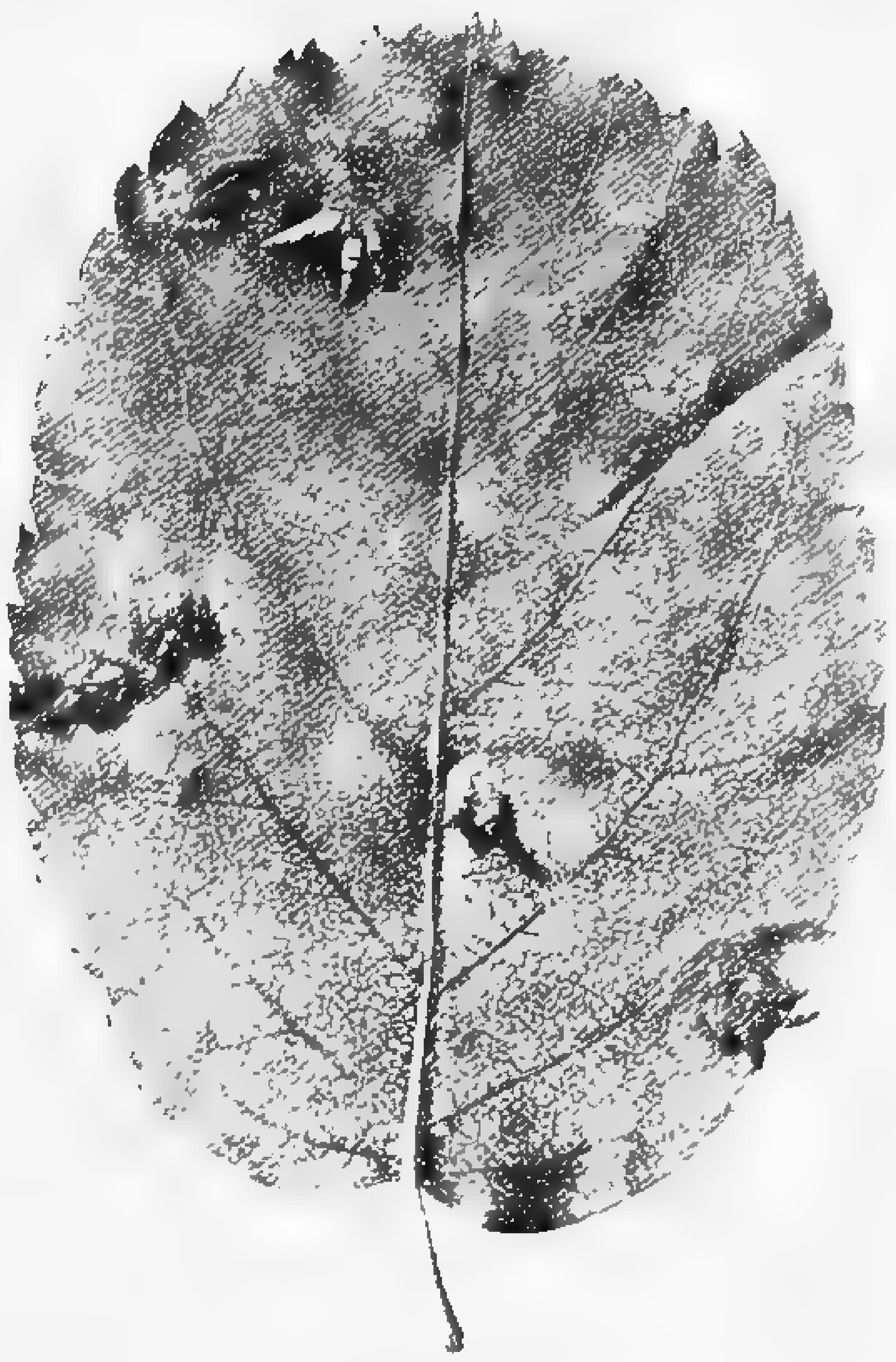

FIG. 40. G. CORNICULANS

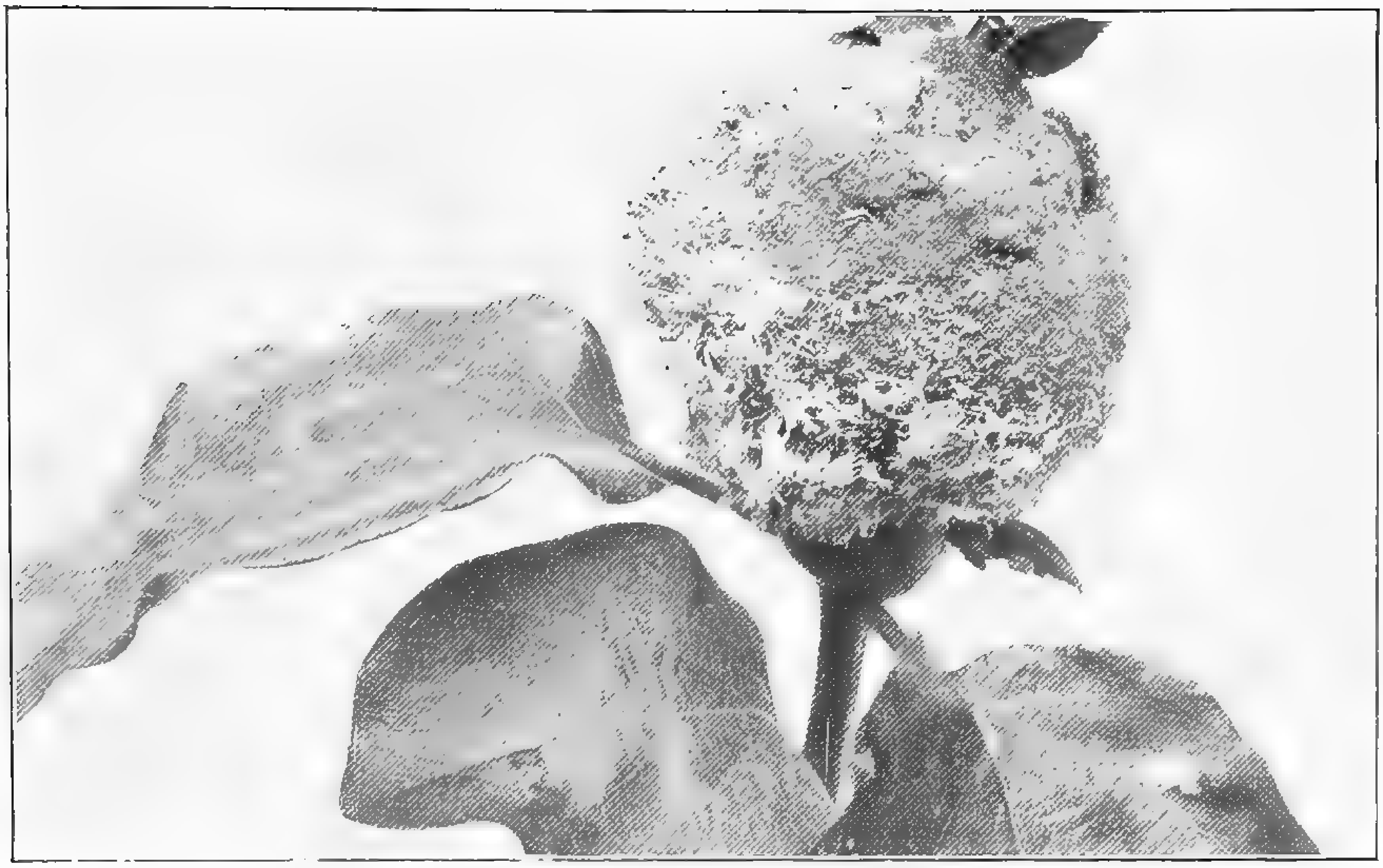

FIG. 41. G. GERMINALE (AFTER STEWART)

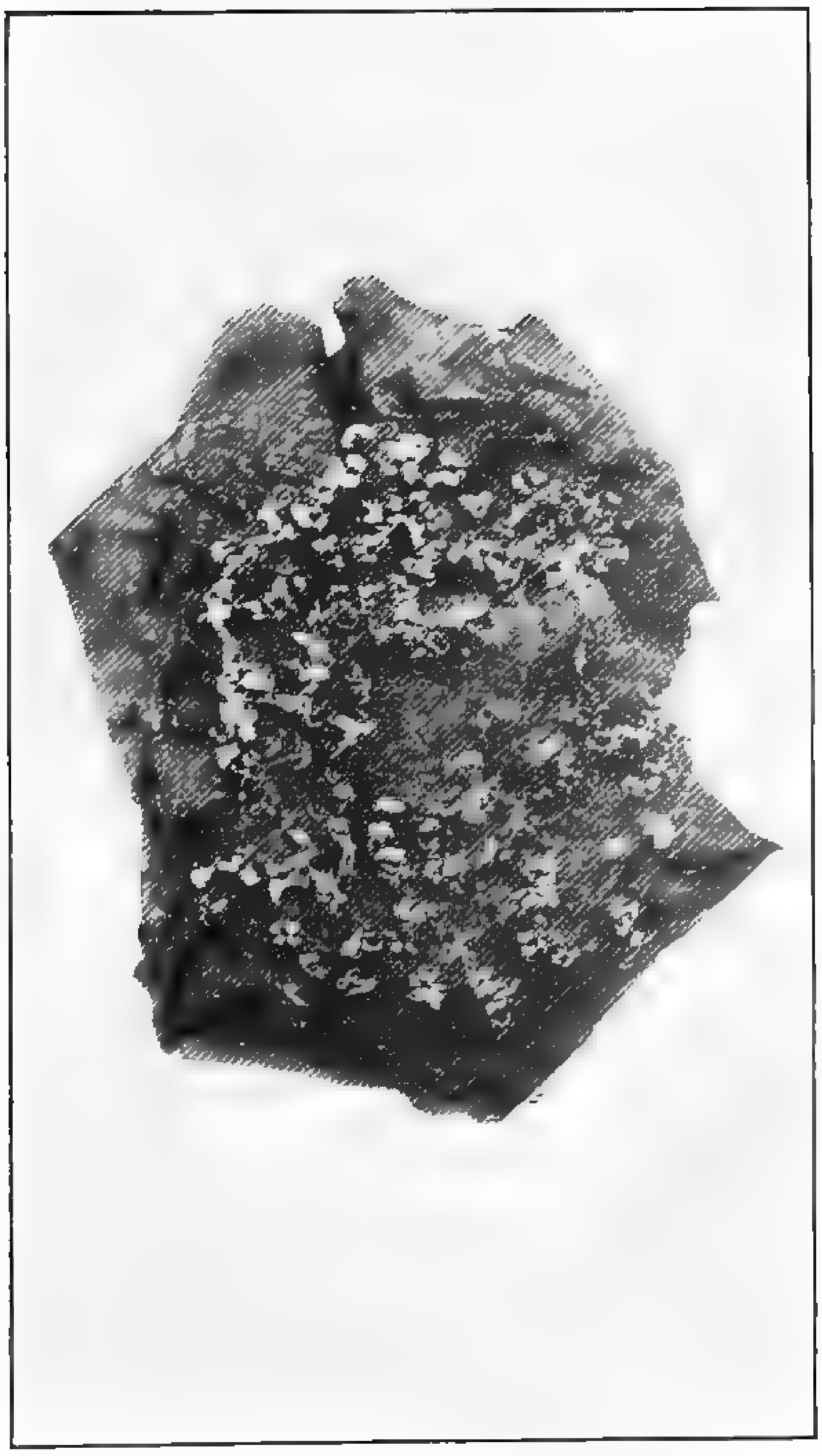

FIG. 42. G. JUNIPERI-VIRGINIANAE

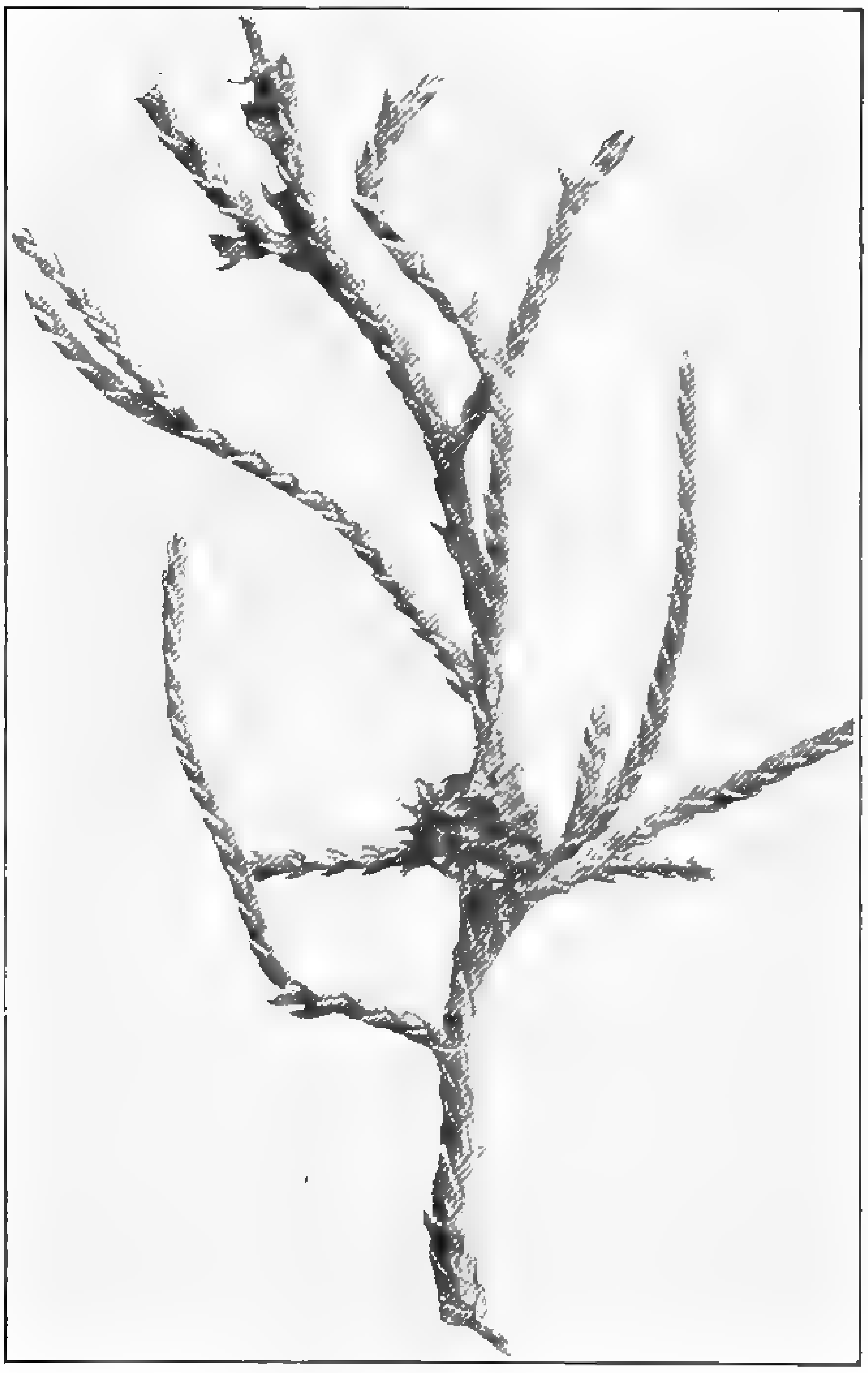

FIG. 43. G. BERMUDIANUM (AECIA)

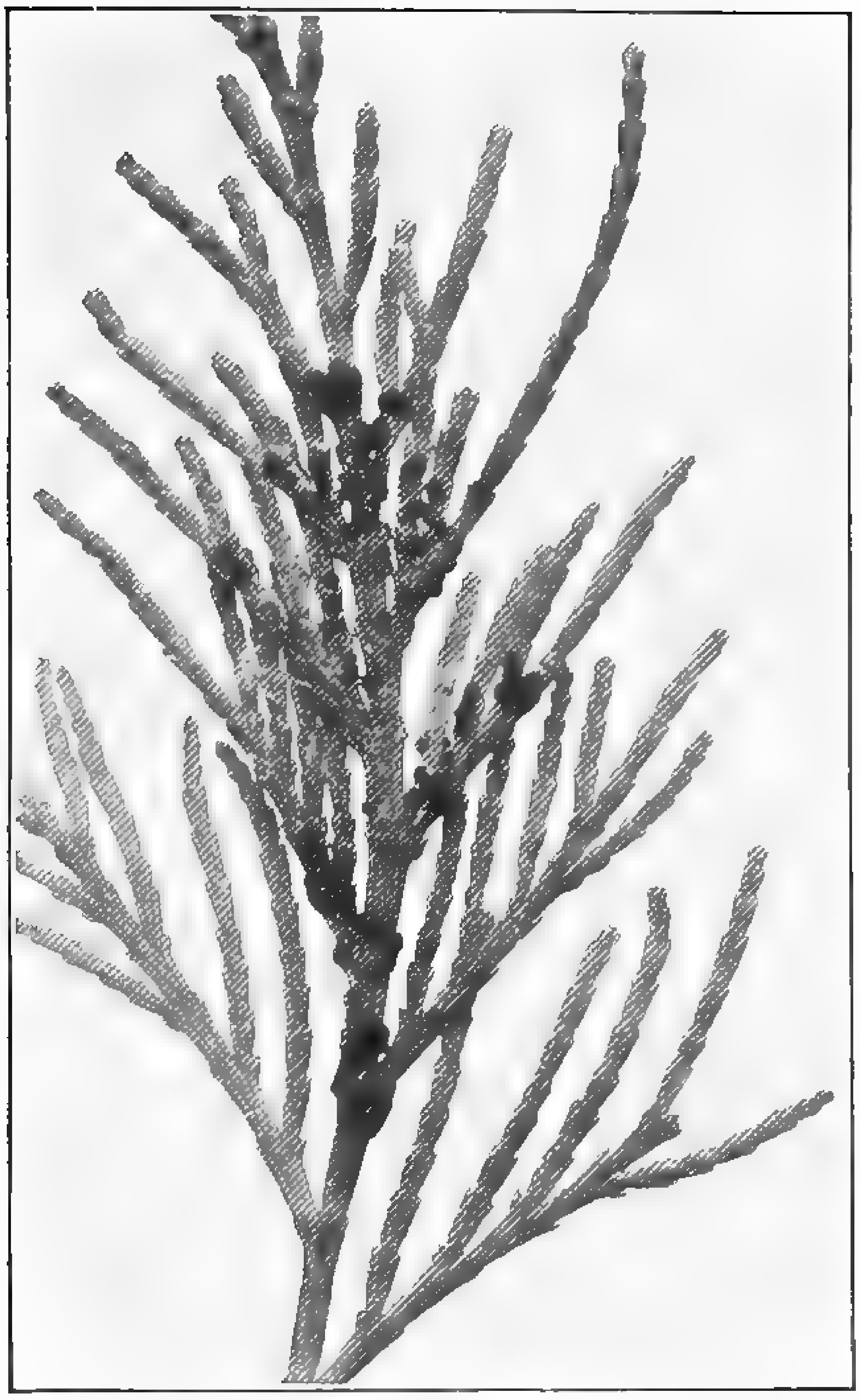

FIG. 44. G. BLASDALEANUM

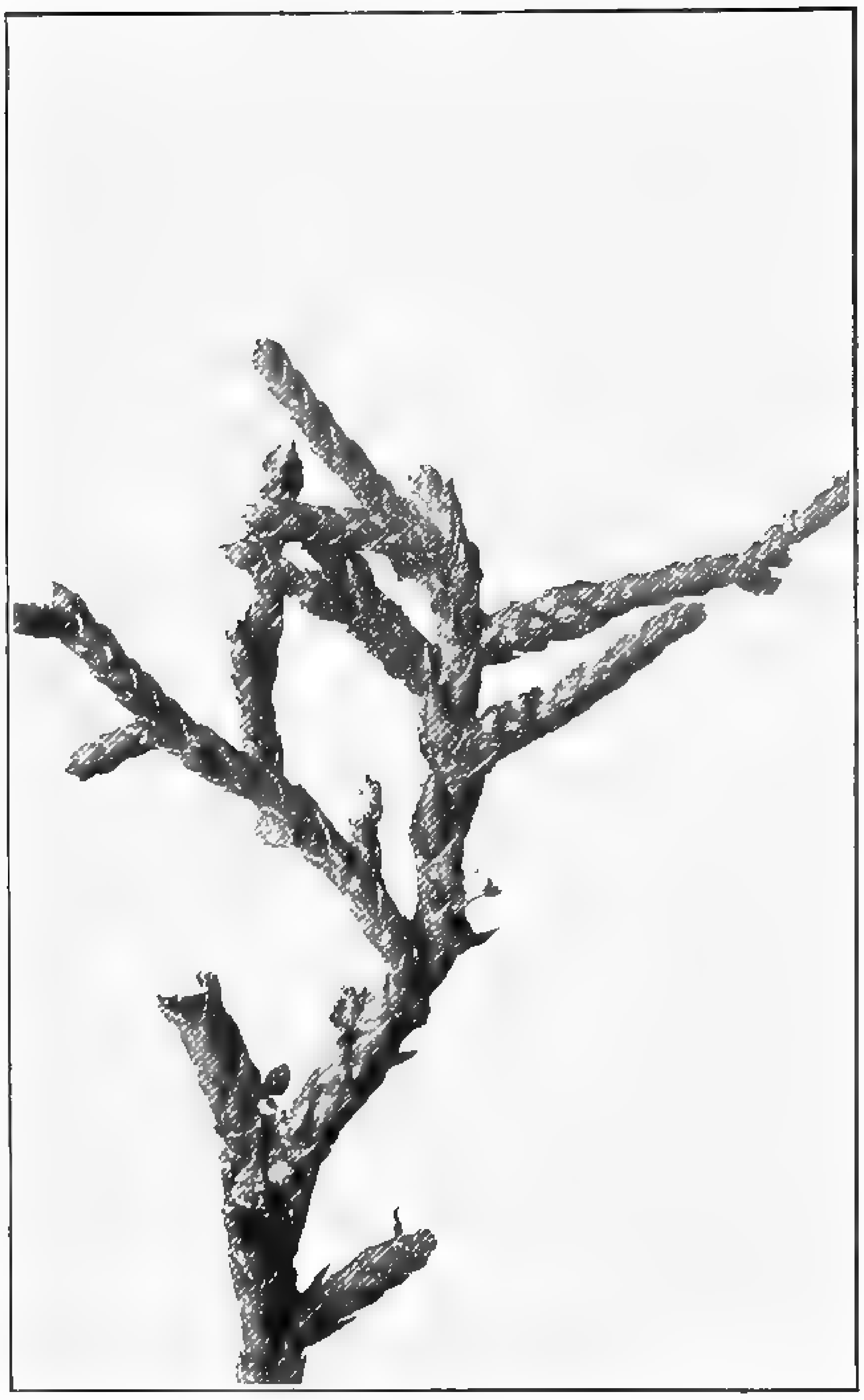

FIG. 45. G. INCONSPICUUM

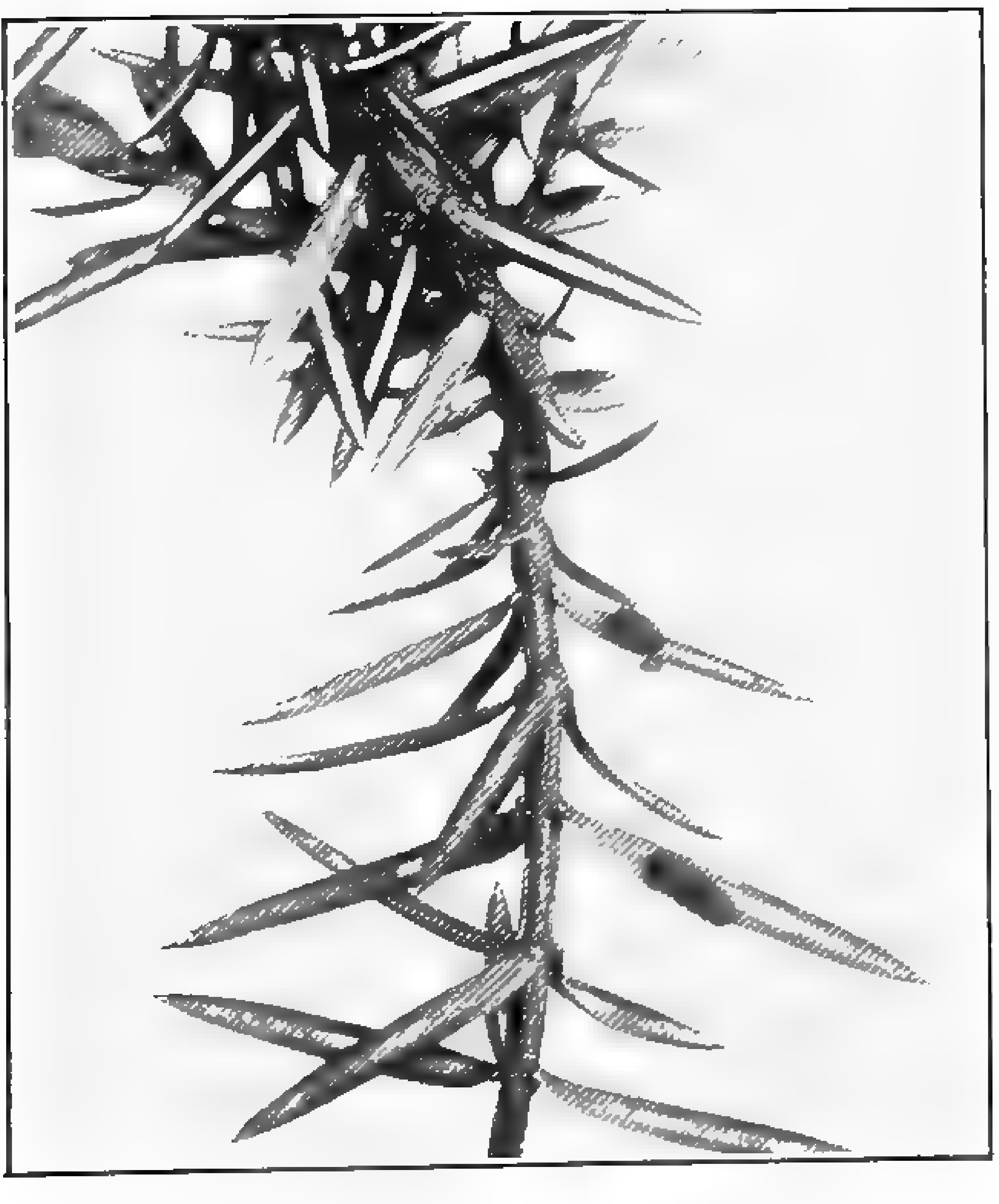

FIG. 46. G. DAVISII

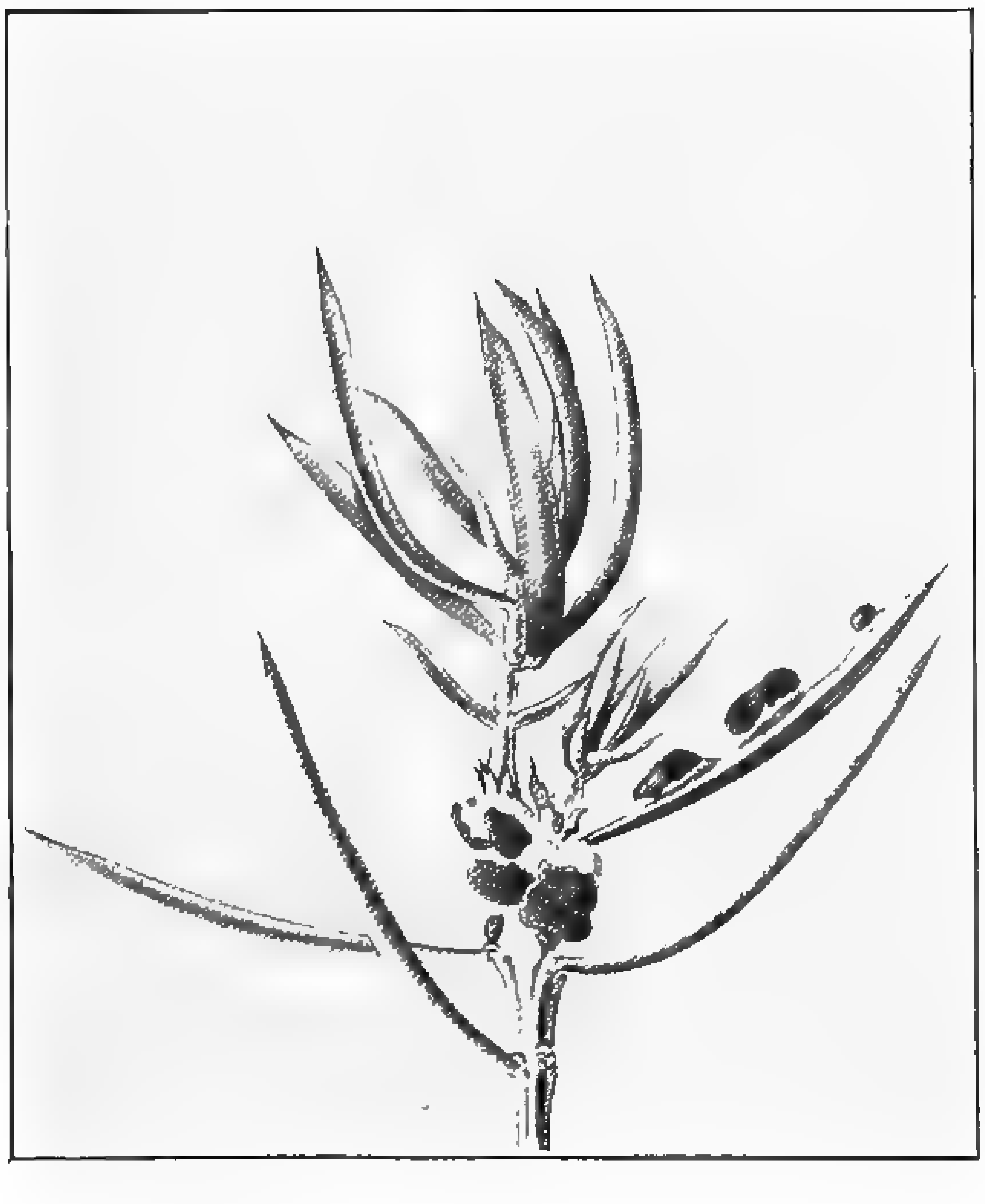

FIG. 47. G. CORNUTUM (AFTER OERSTED)

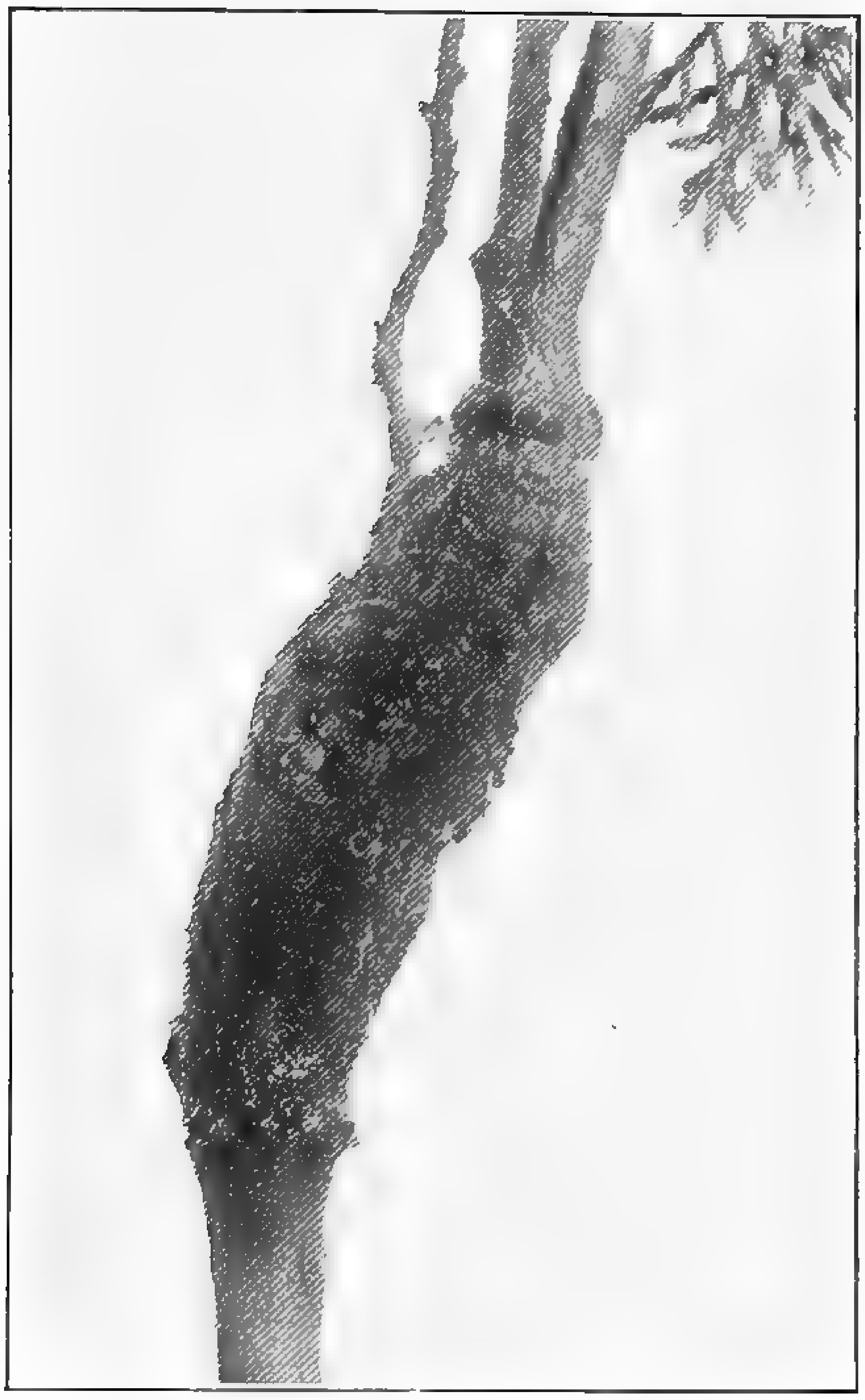

FIG. 48. G. BOTRYAPITES

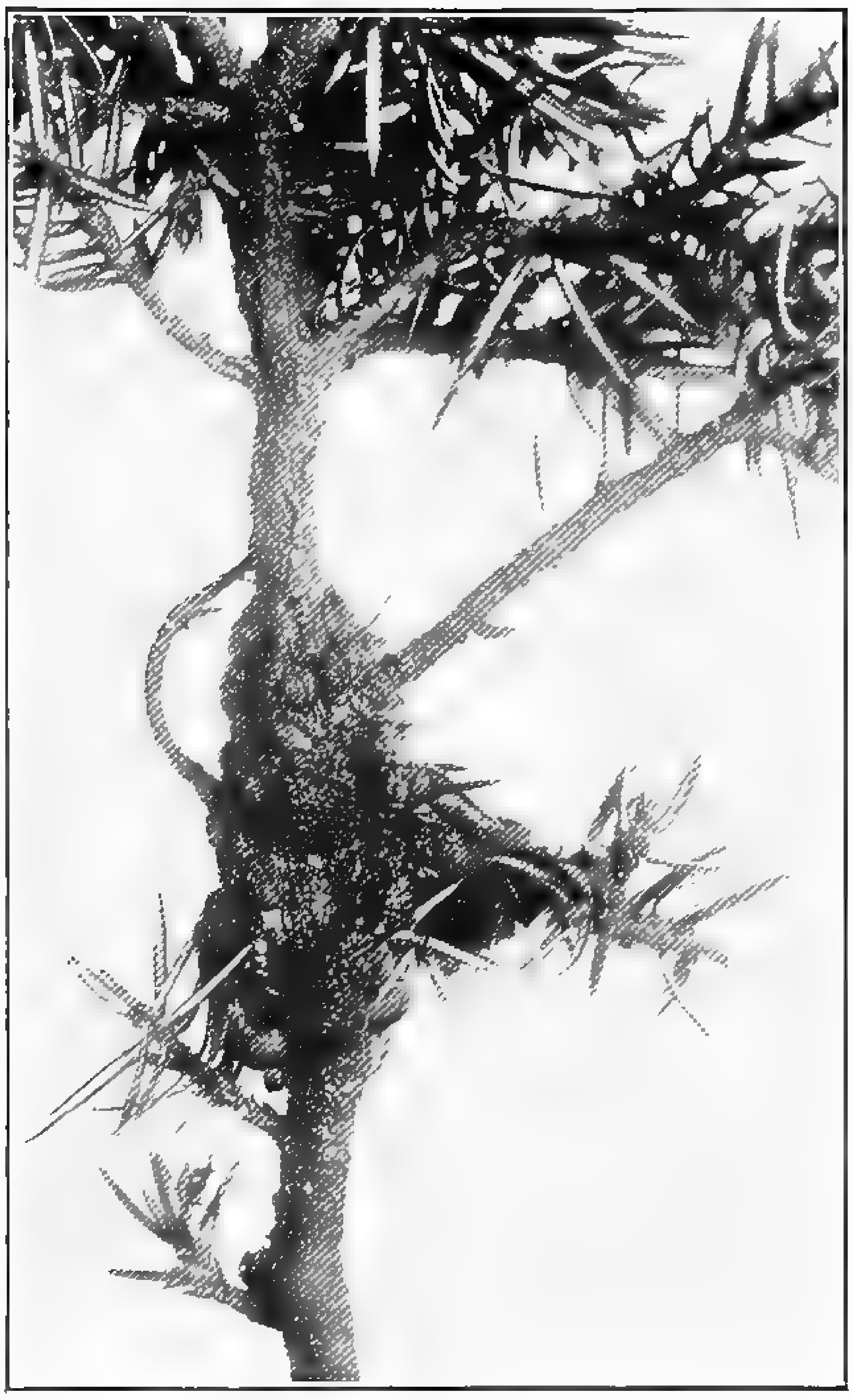

FIG. 49. G. JUNIPERINUM

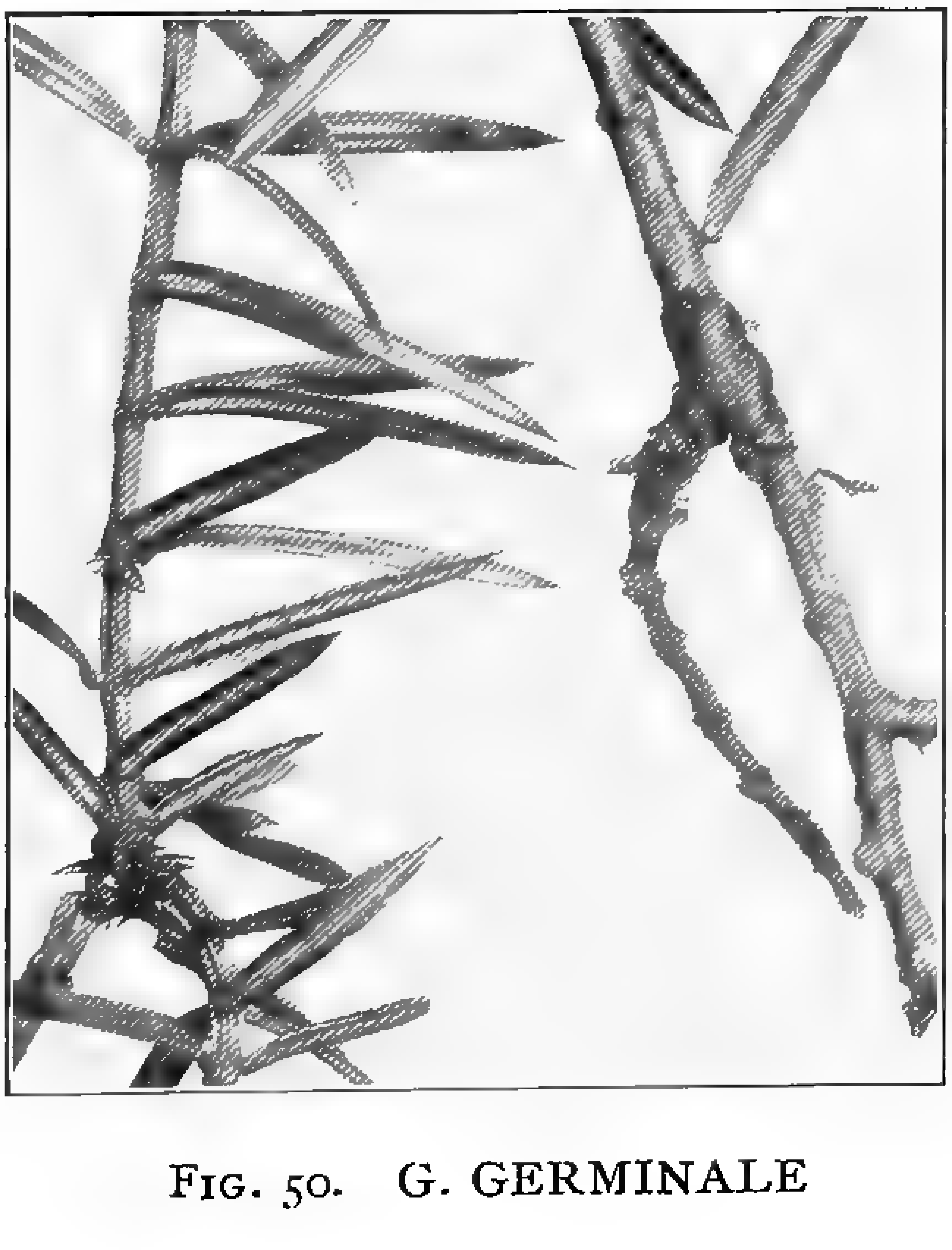

FIG. 50. G. GERMINALE

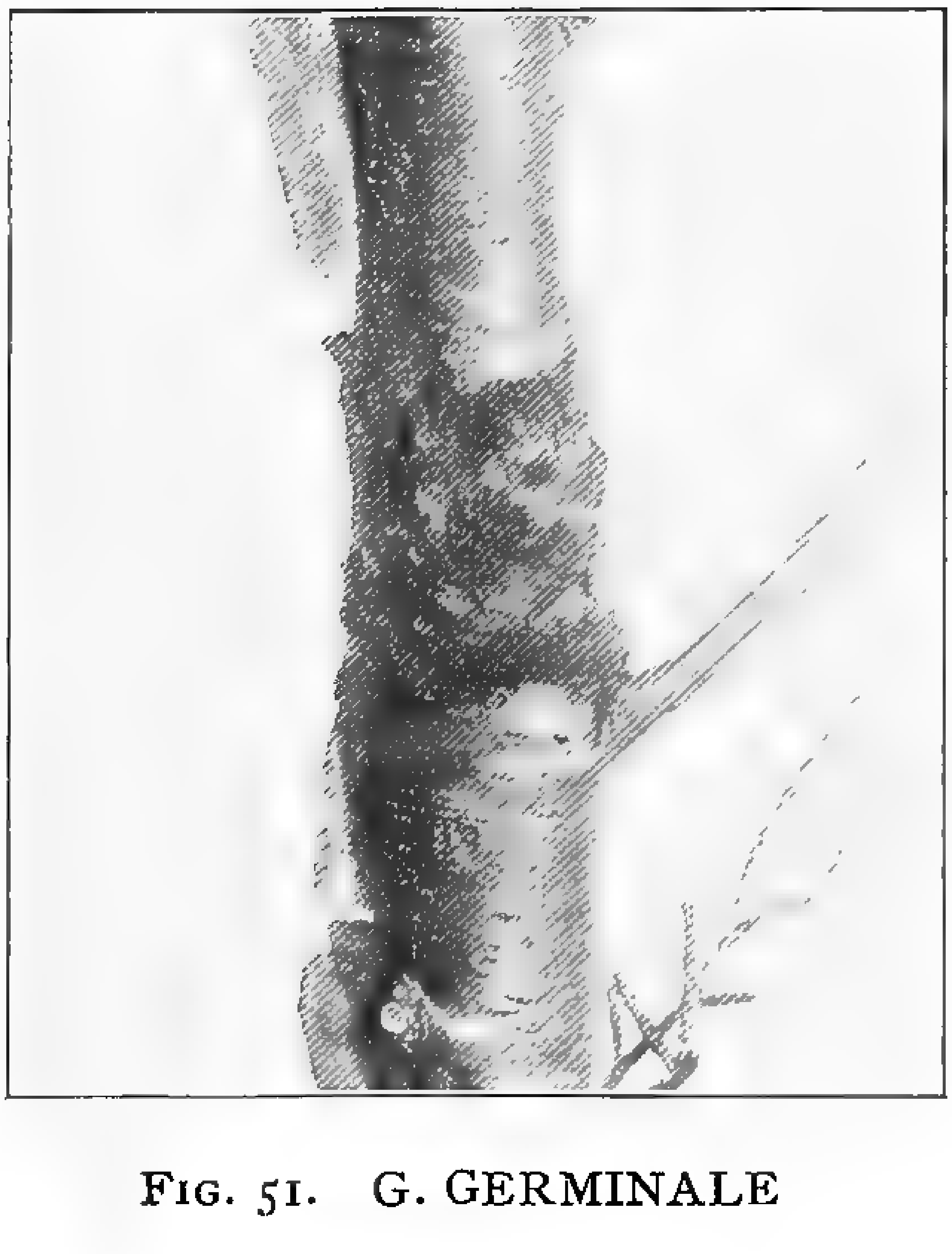

FIG. 51. G. GERMINALE

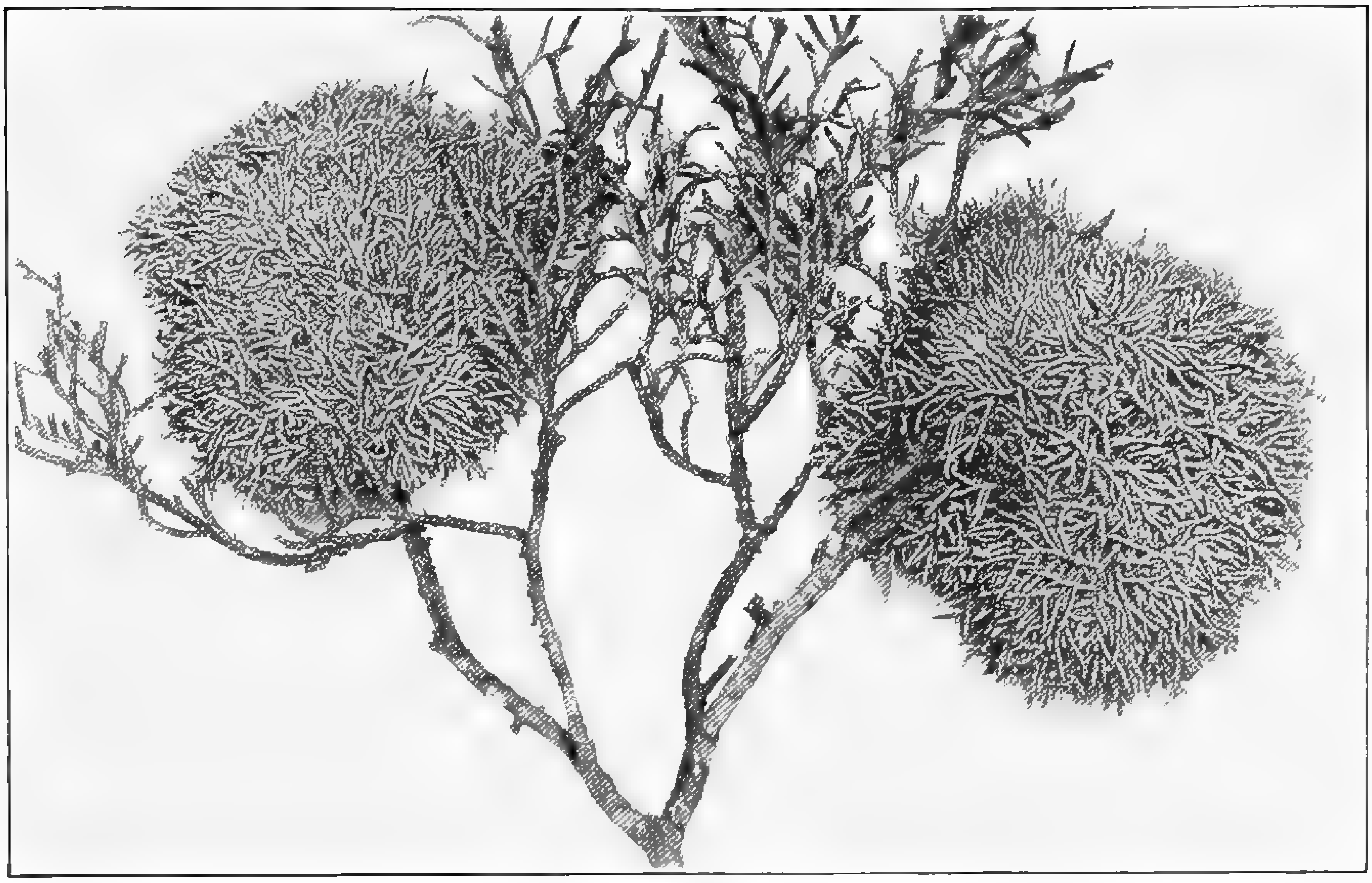

FIG. 52. G. KERNIANUM (AFTER BETHEL)

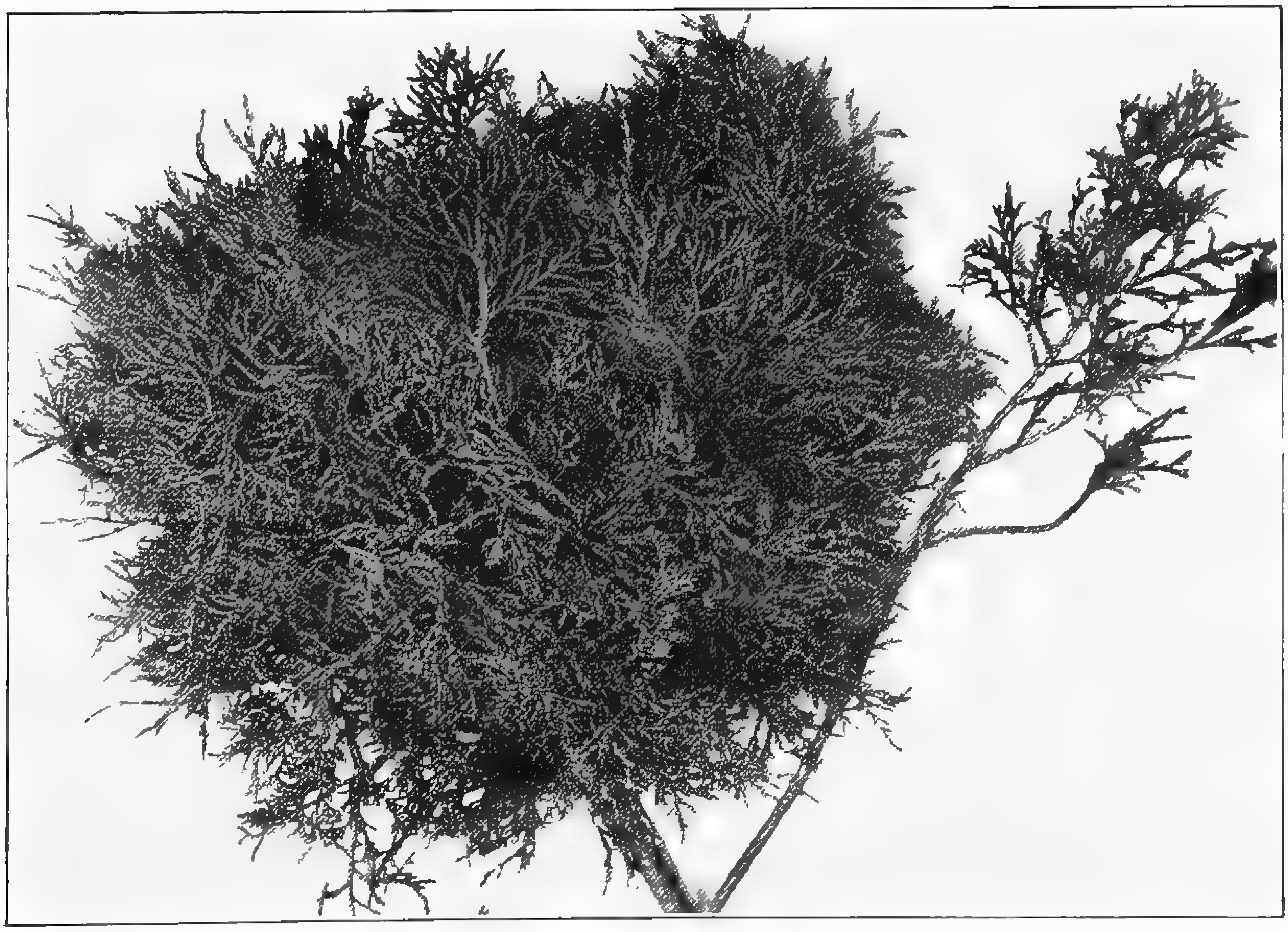

FIG. 53. G. JUVENESCENS (AFTER BETHEL)

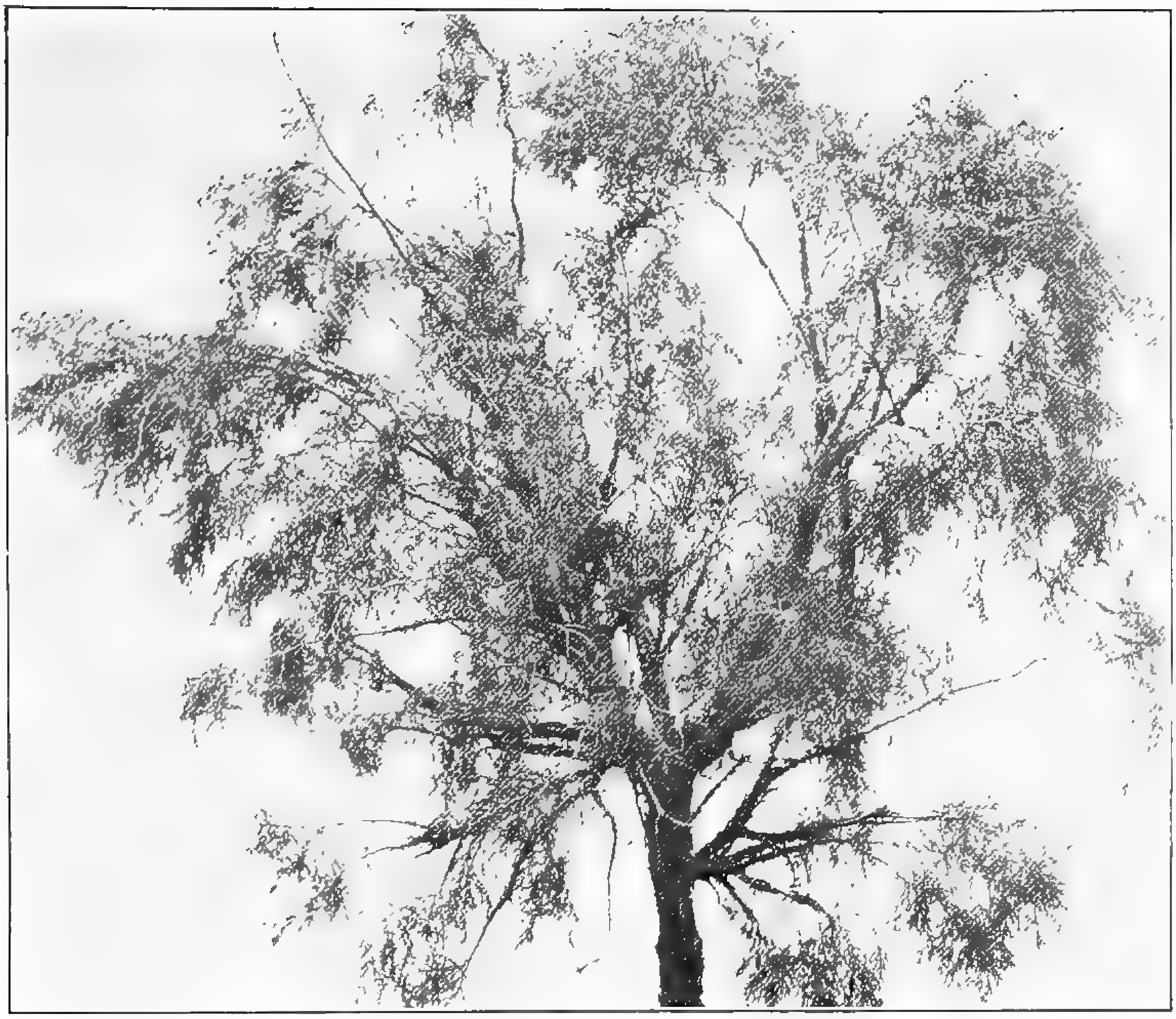

FIG. 54. G. NIDUS-AVIS

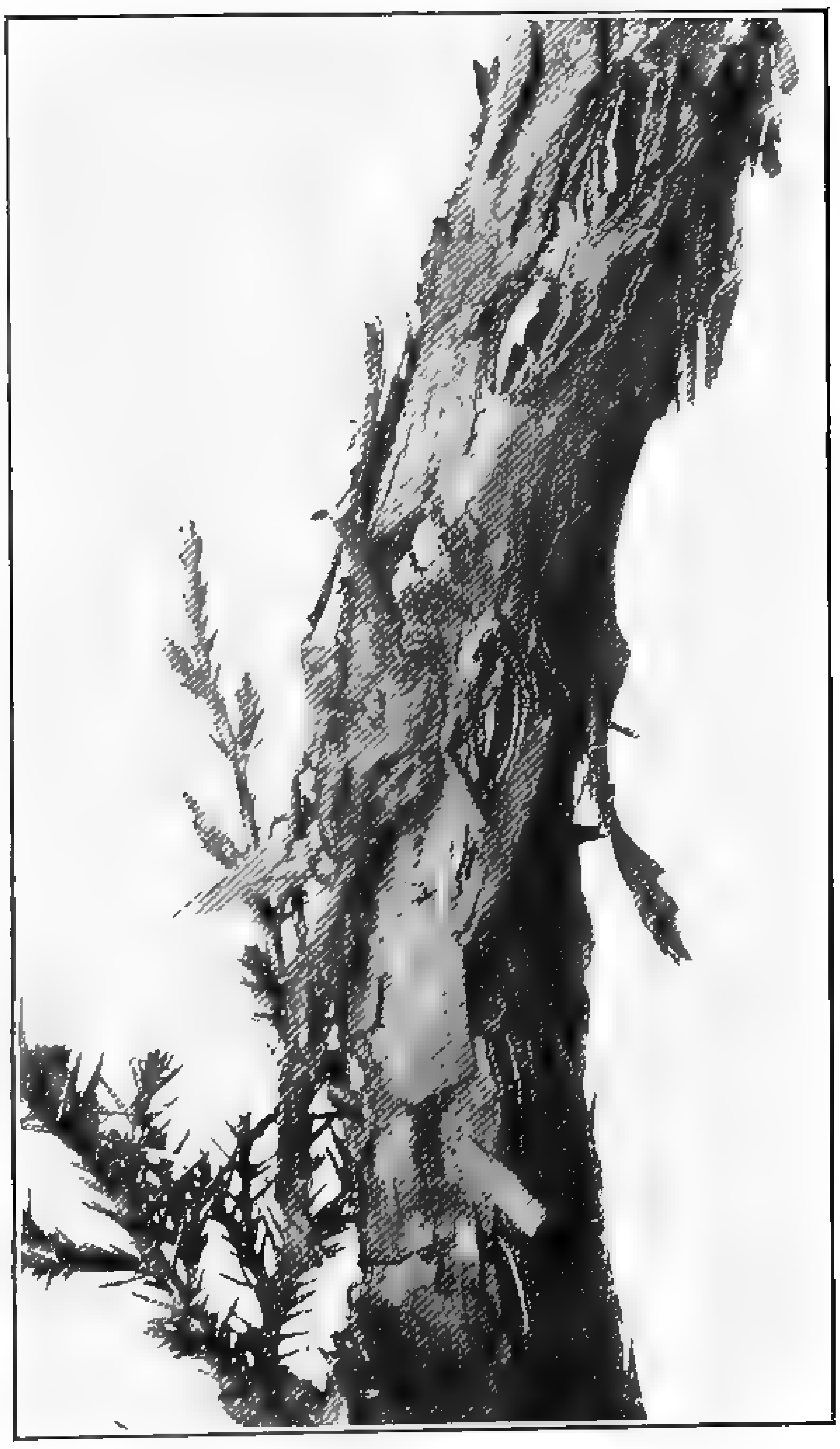

FIG. 55. G. NIDUS-AVIS

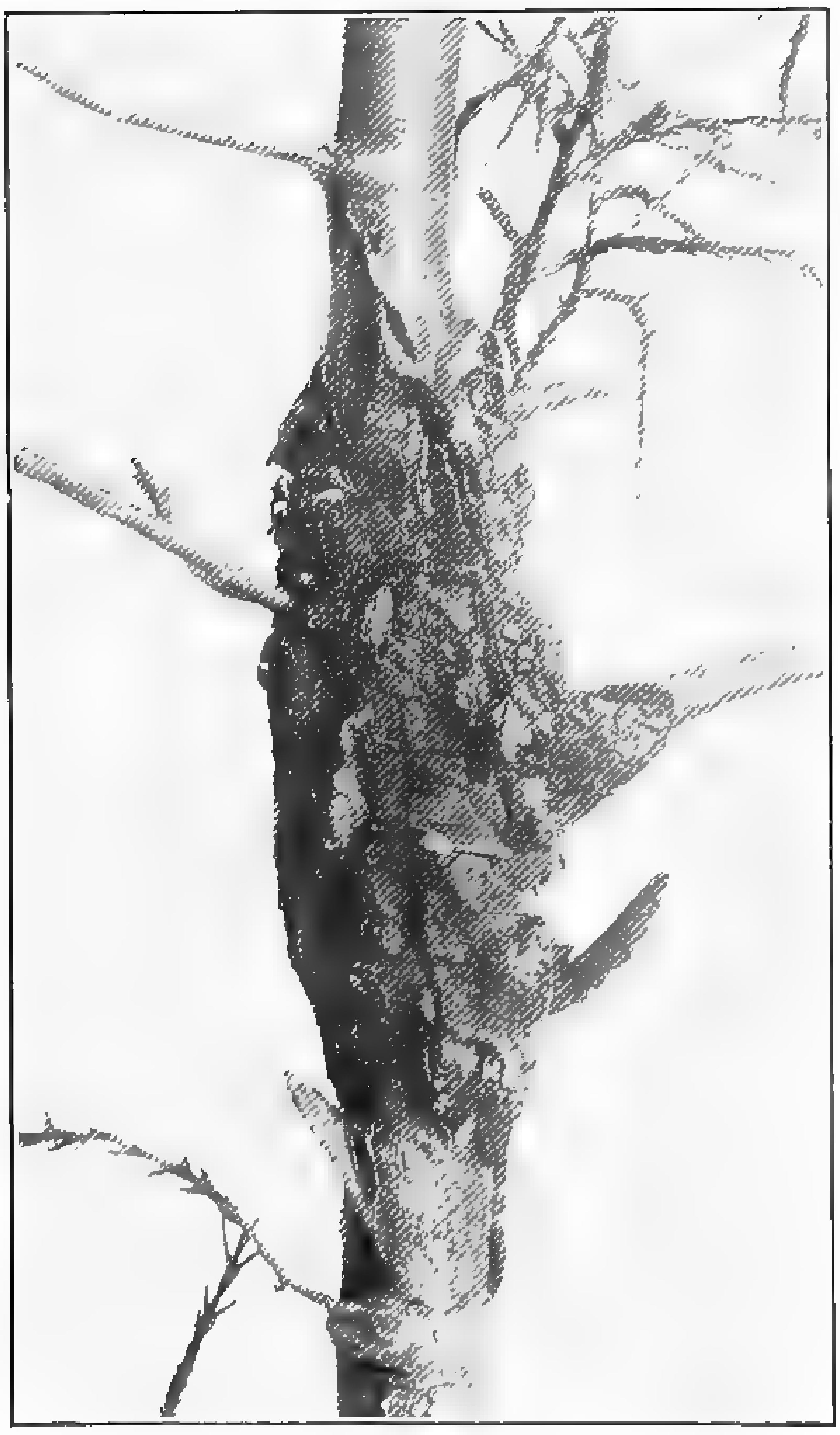

FIG. 56. G. EXTERUM

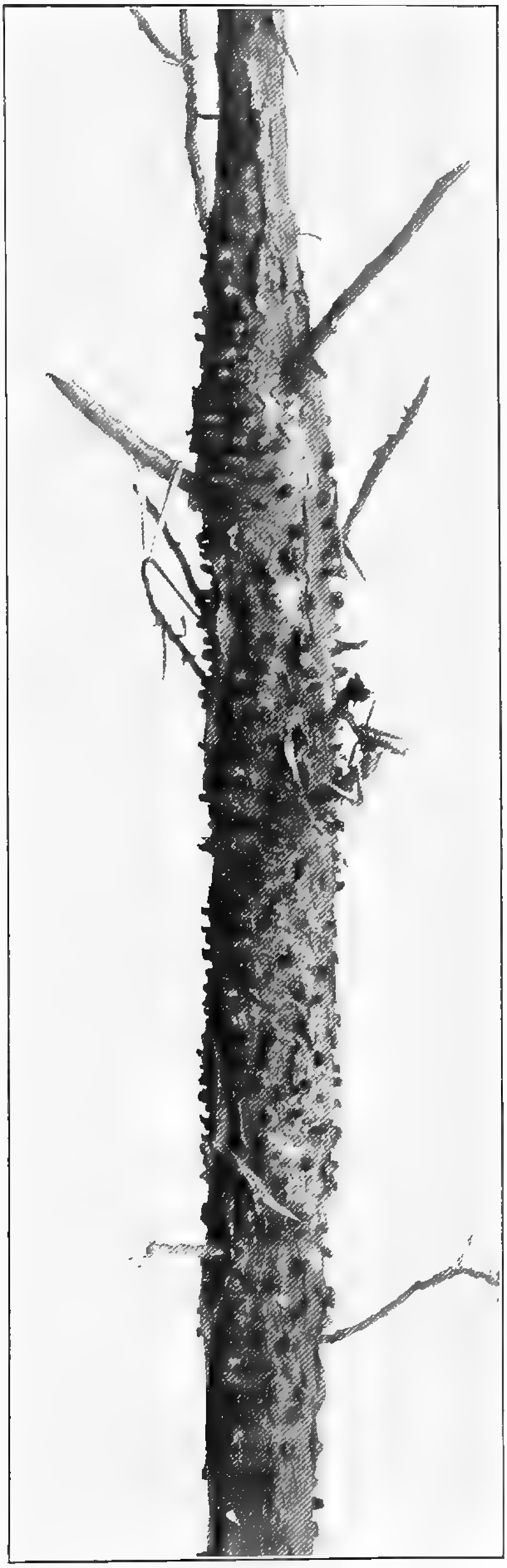

FIG. 57. G. CLAVARIAEFORME
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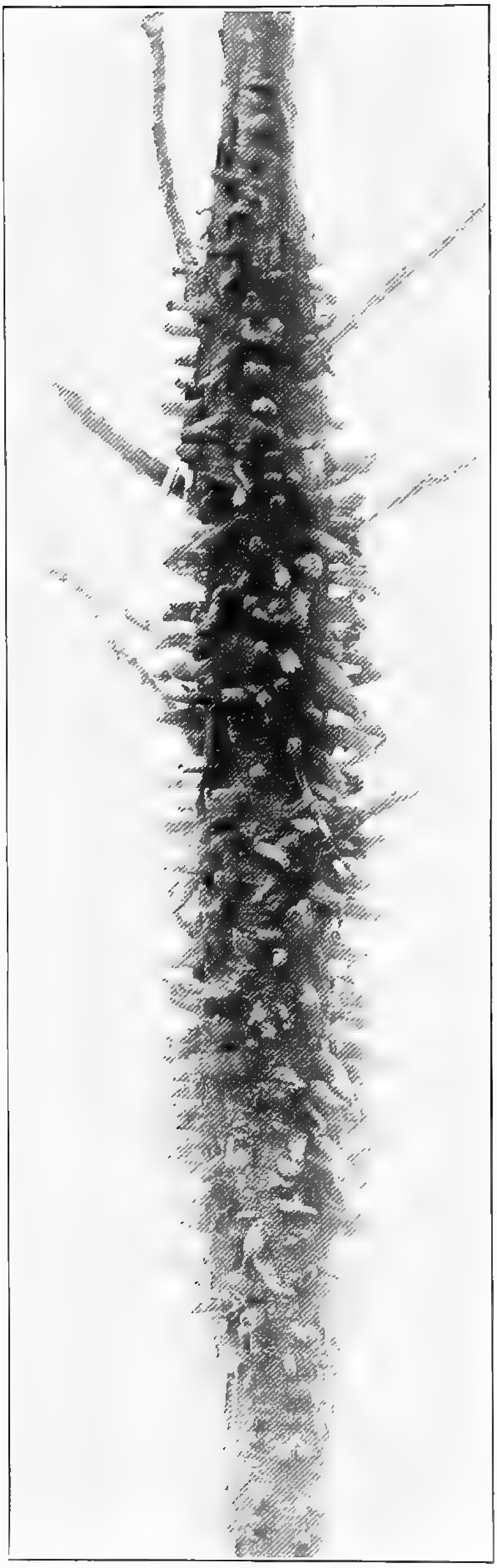

FIG. 58. G. CLAVARIAEFORME
(AFTER EXPANSION)

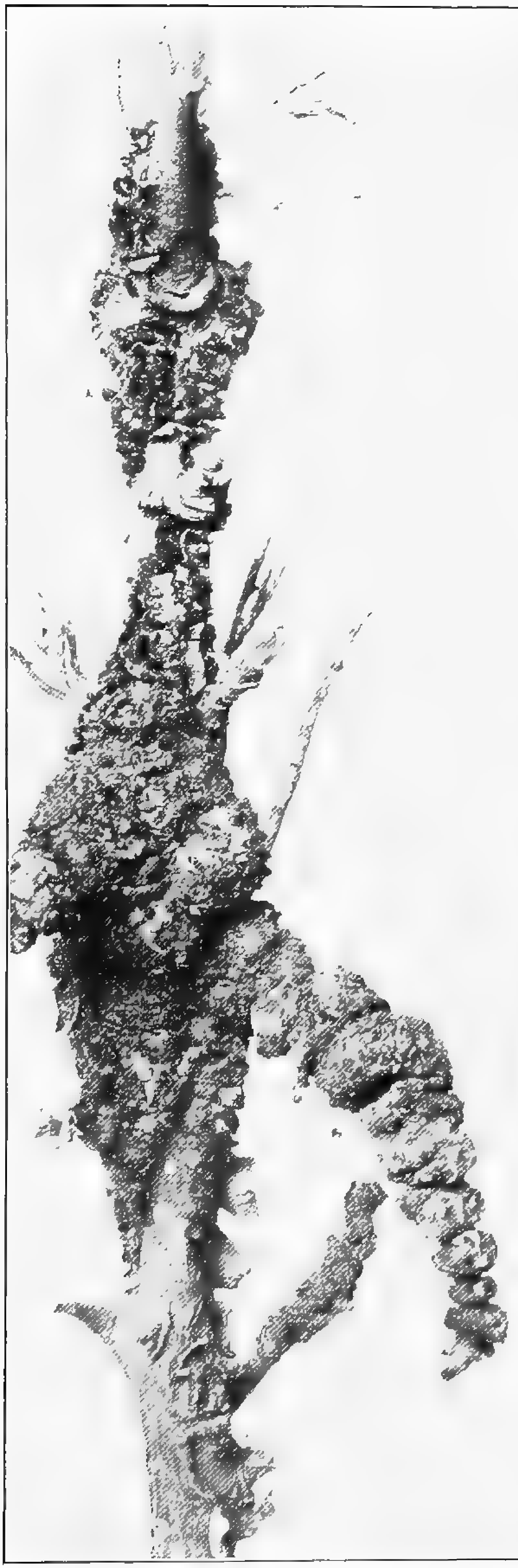

Fig. 59. G. BETHELI

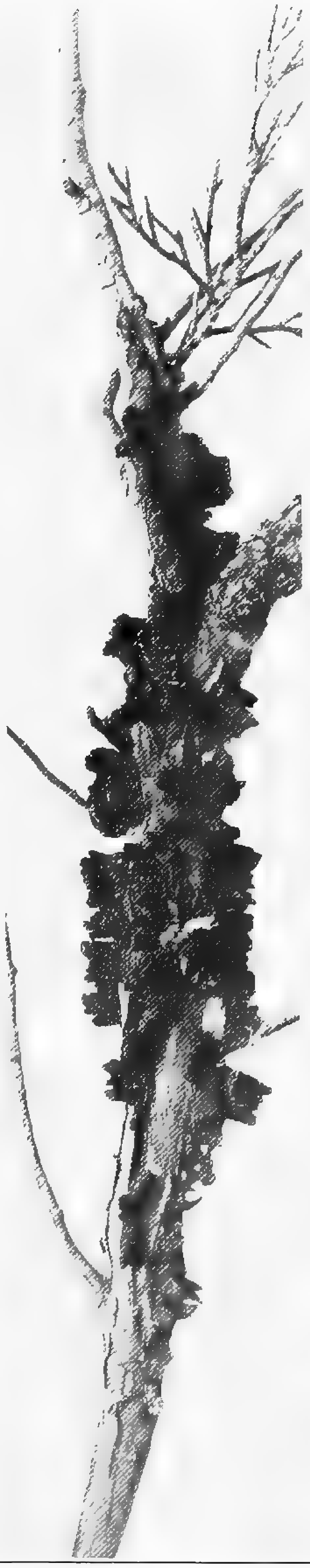

Fig. 60. G. EFFUSUM

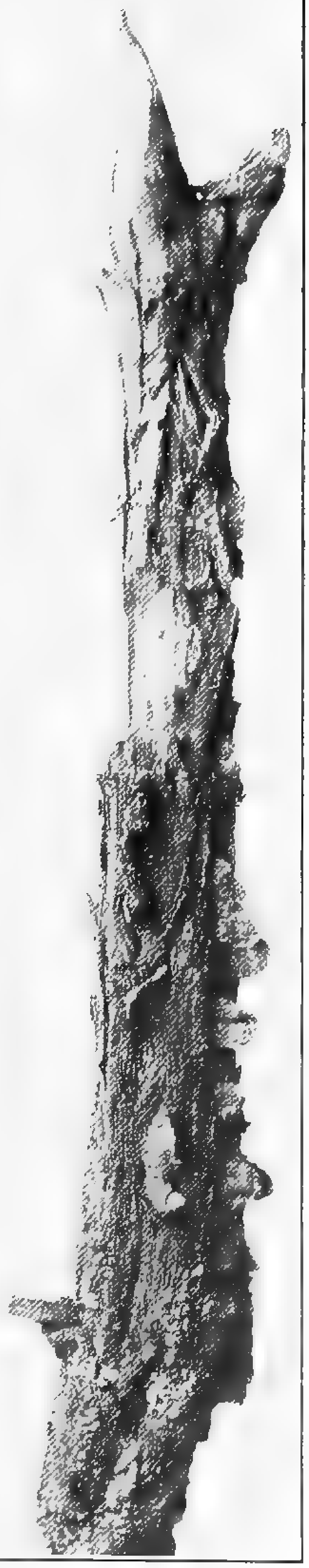

Fig. 61. G. GRACILENS

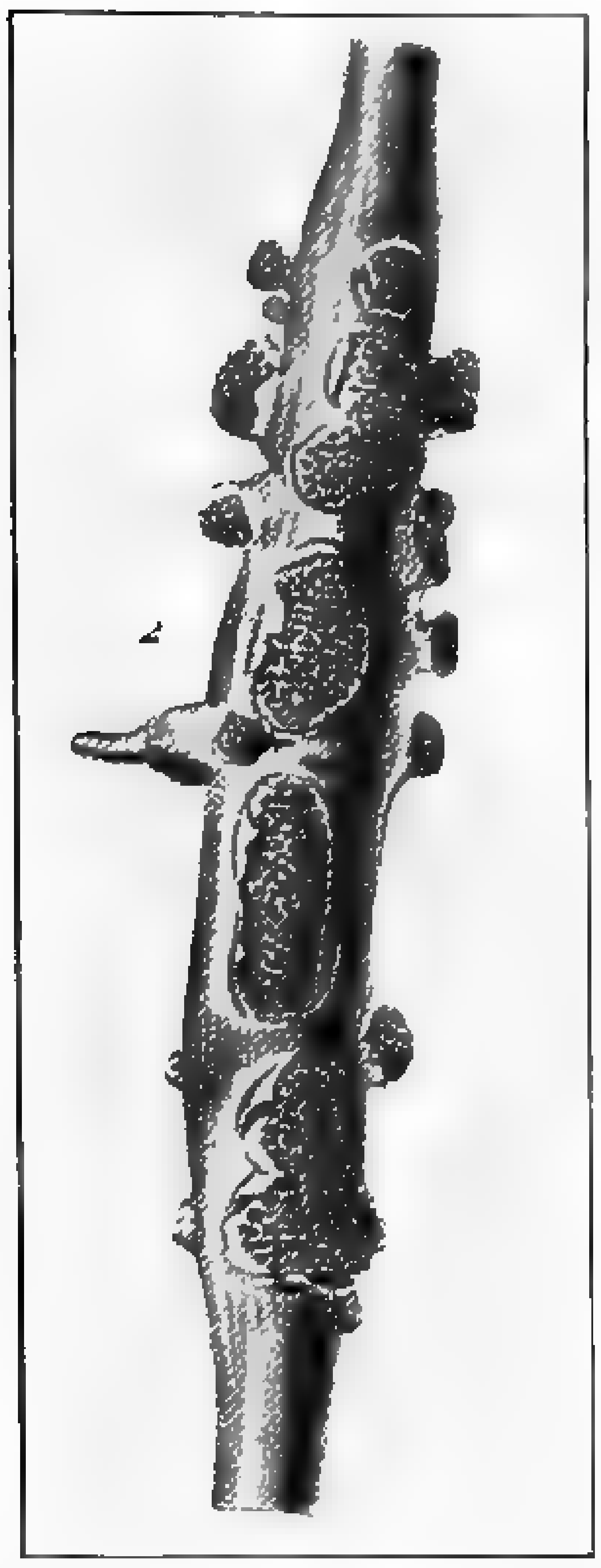

FIG. 62. G. CORNUTUM
(AFTER OERSTED)

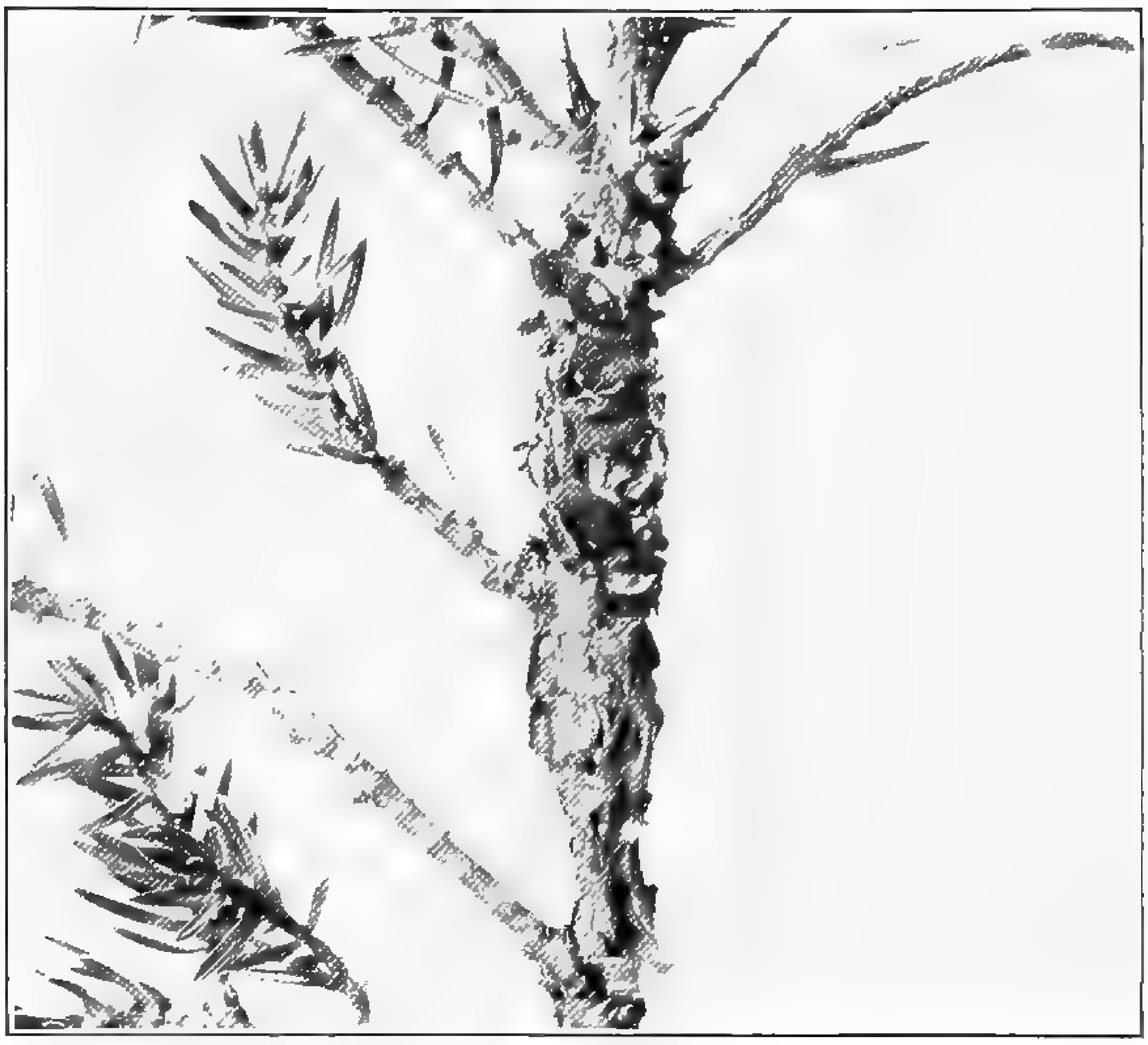

FIG. 63. G. CORNUTUM

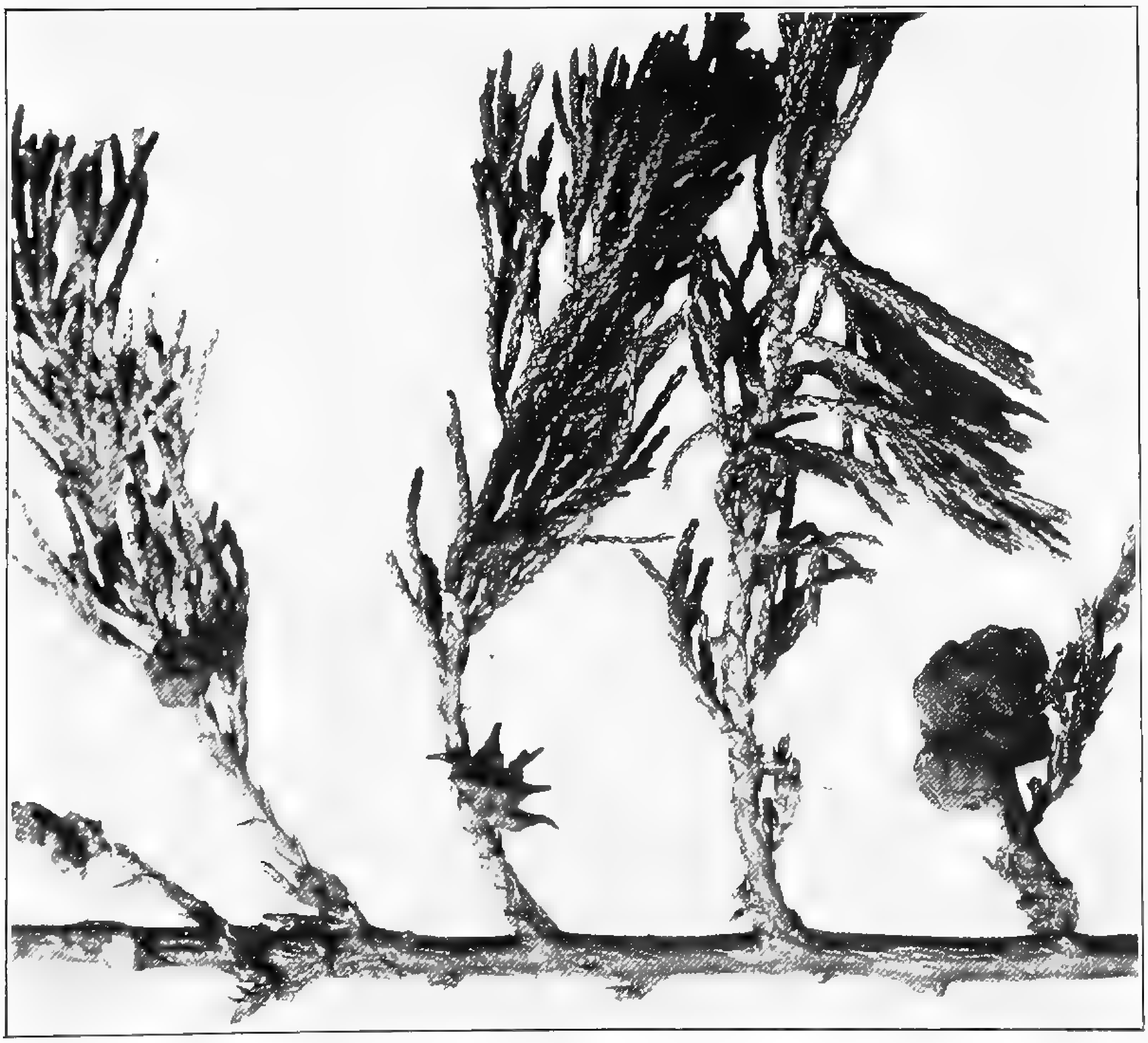

FIG. 64. G. CORNICULANS

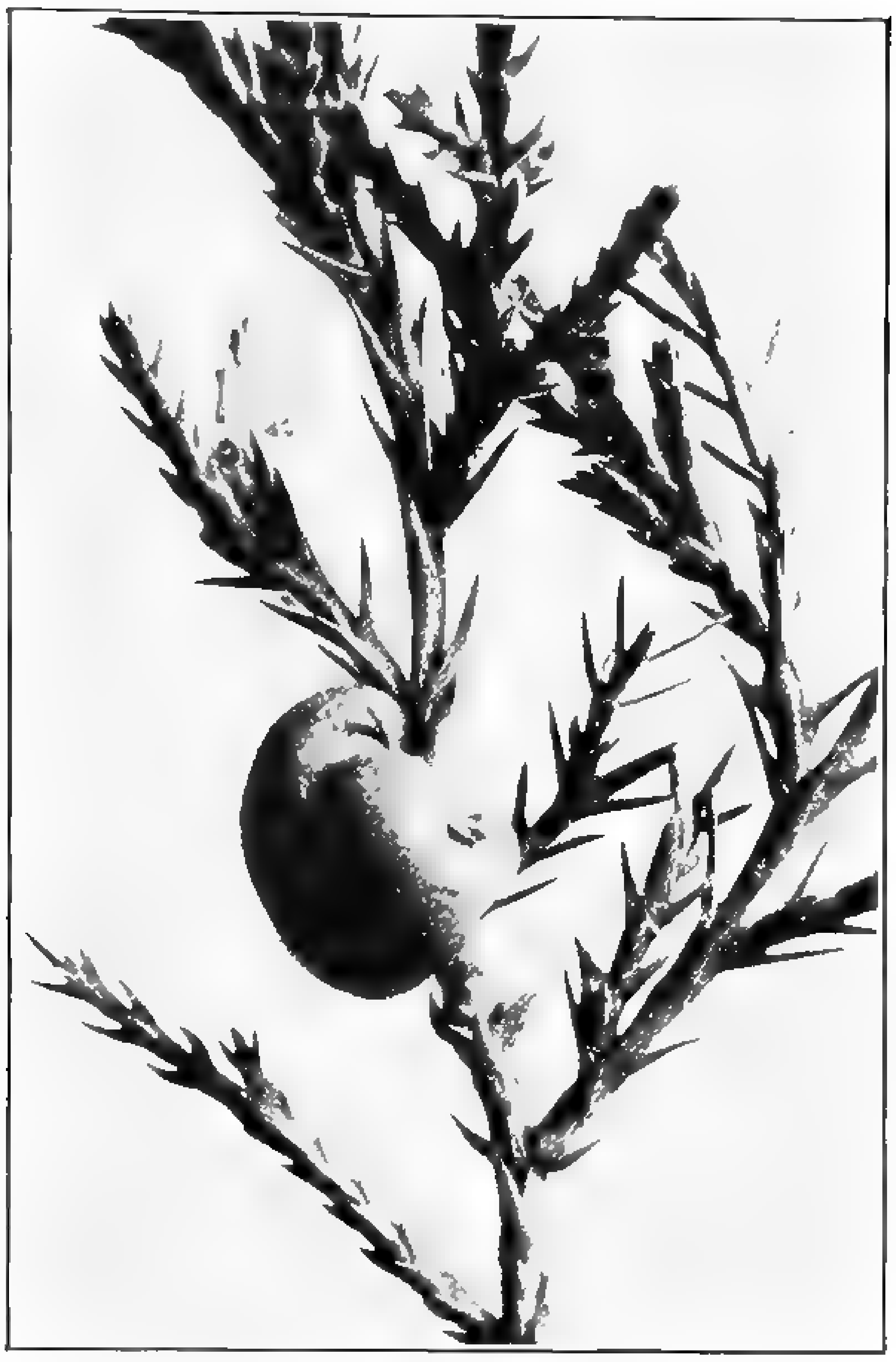

FIG. 66. G. JUNIPERI-VIRGINIANAE

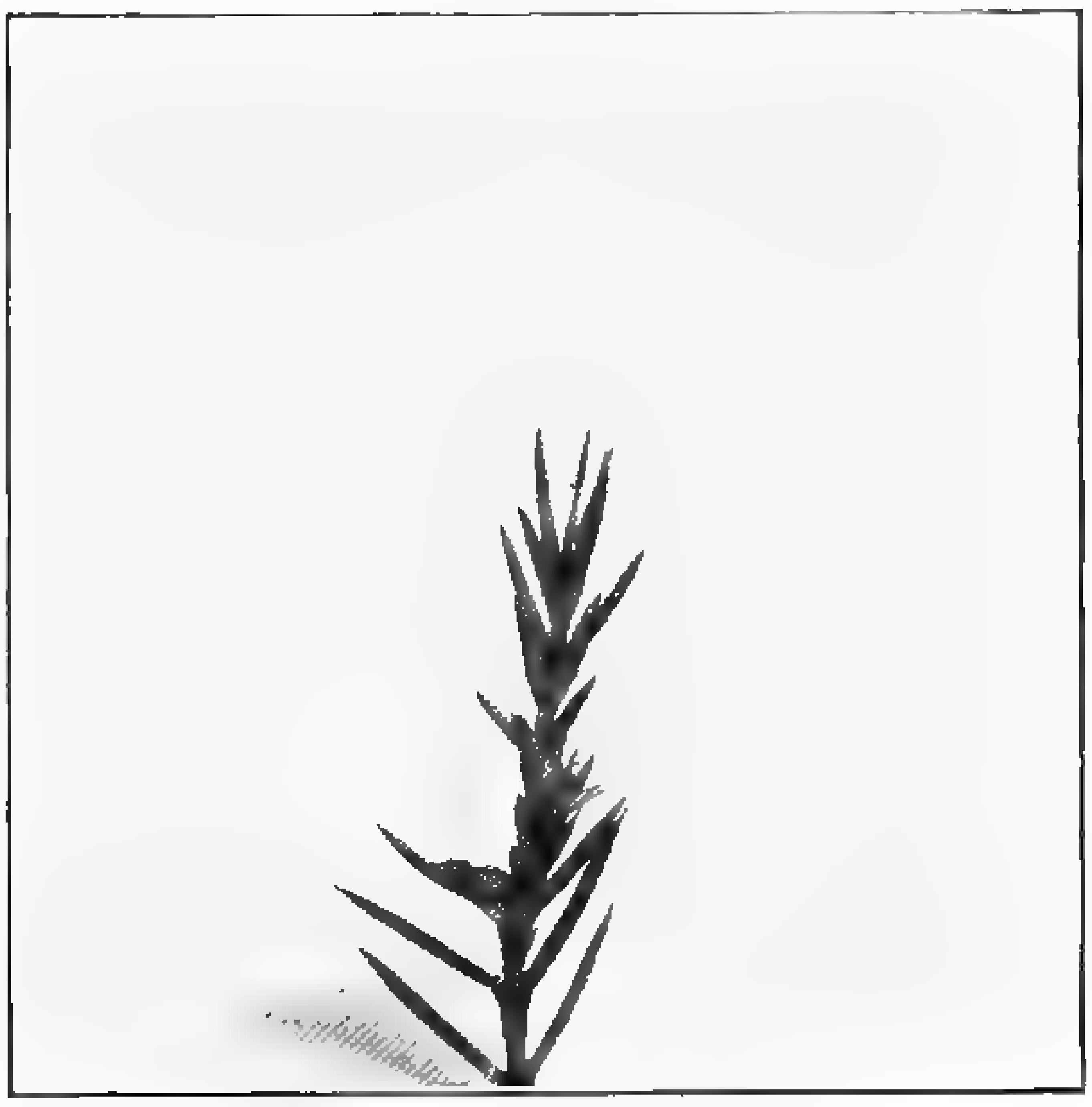

FIG. 65. G. JUNIPERI-VIRGINIANAE

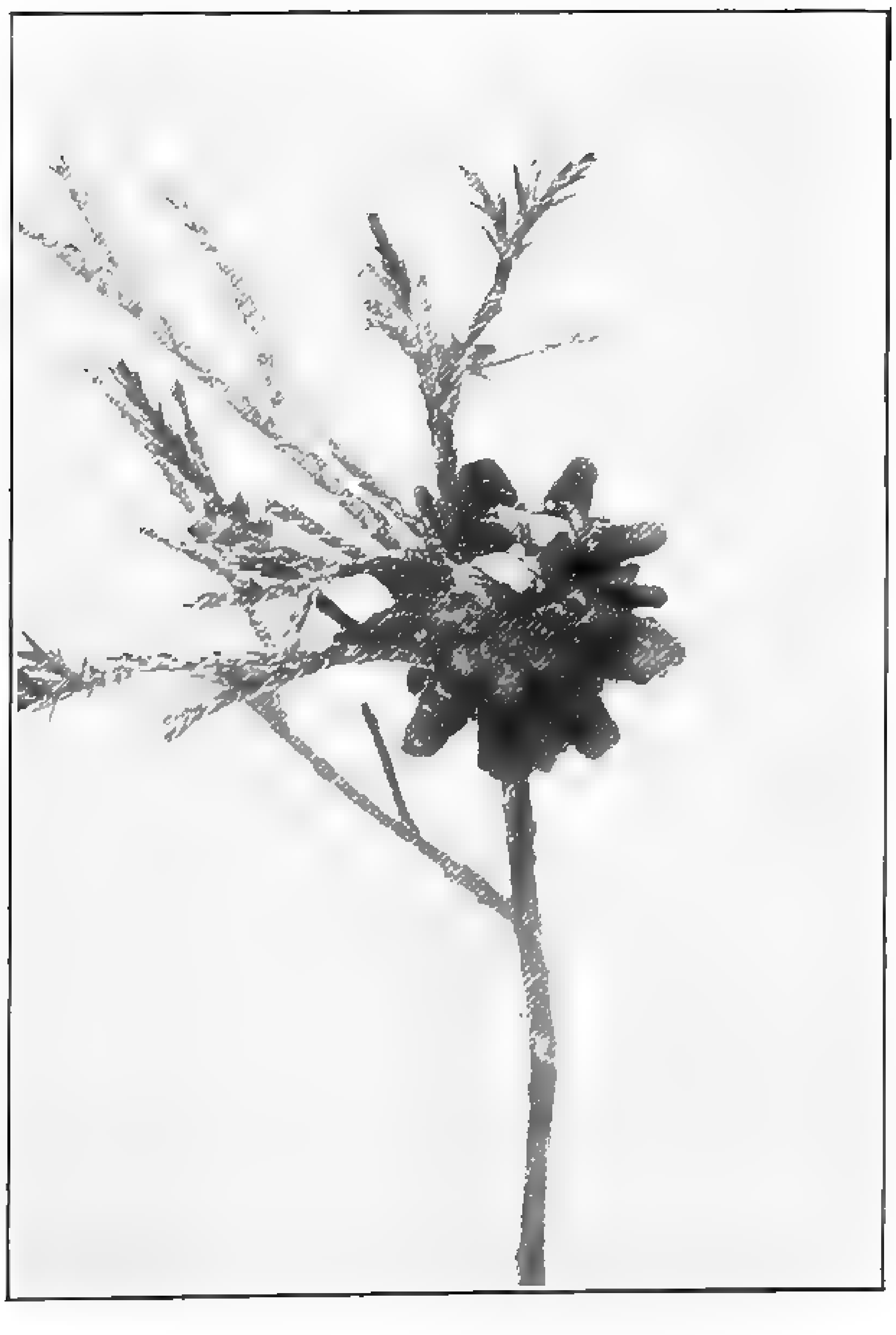

FIG. 67. G. GLOBOSUM

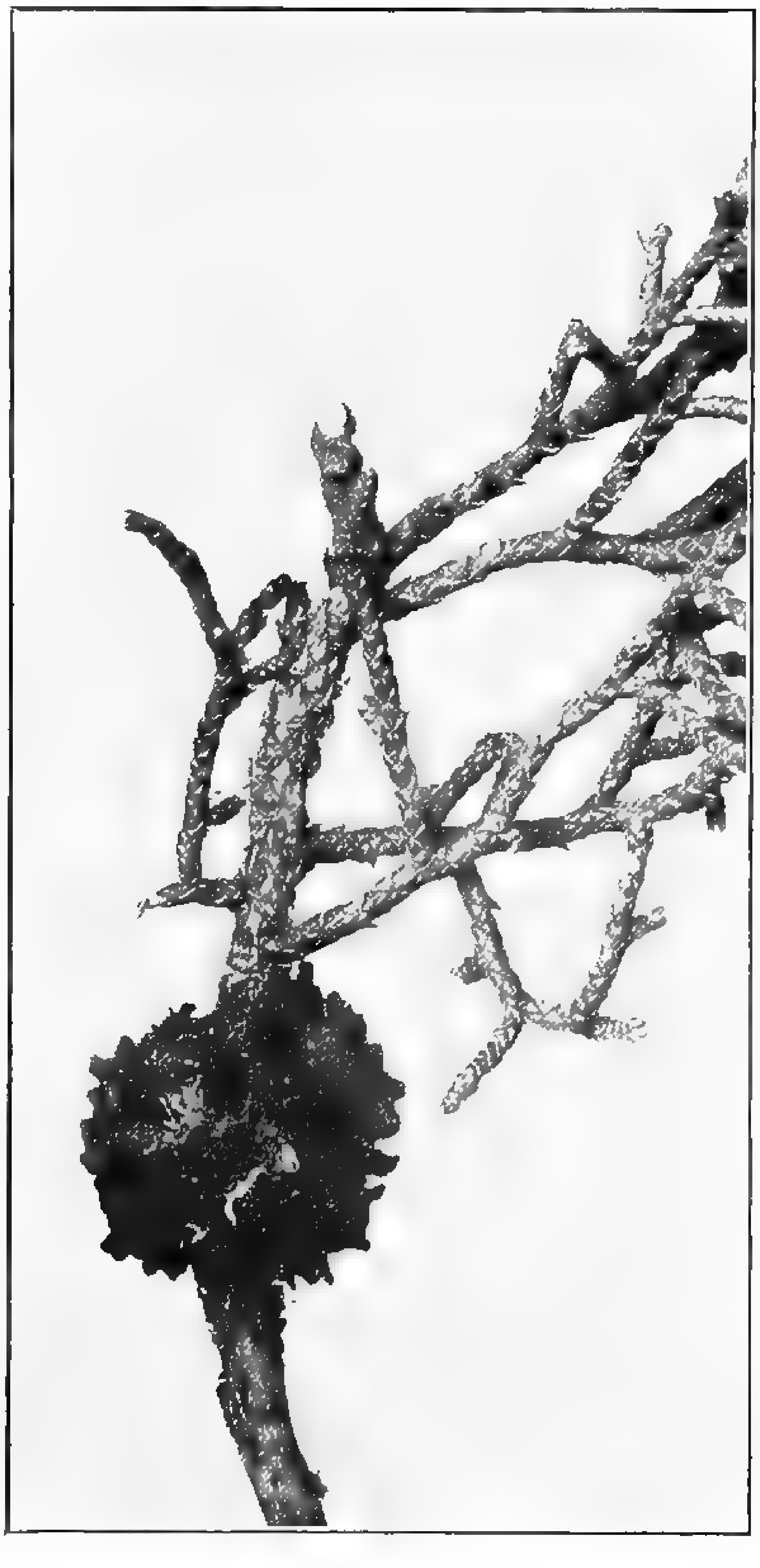

FIG. 68. G. NELSONI

PLATE 155

Fig. 48. *G. Botryapites* on *Chamaecyparis thyoides;* telia hemispheric on a fusiform enlargement.

Fig. 49. *G. juniperinum* on *J. sibirica;* telia applanate on fusiform swelling.

Fig. 50. *G. germinale* on *J. sibirica* (§ *Oxycedrus*); telia small, caulicolous, not causing much hypertrophy.

Fig. 51. *G. germinale* on *J. virginiana* (§ *Sabina*); telia small, caulicolous, not causing much hypertrophy.

PLATE 156

Fig. 52. *G. Kernianum* on *Juniperus utahensis;* two dense witches' brooms, the leaves not showing a reversion to the juvenile form. After Bethel.

Fig. 53. *G. juvenescens* on *Juniperus scopulorum;* a witches' broom, the leaves showing the tendency, characteristic of this species, to revert to the juvenile form. After Bethel.

PLATE 157

Fig. 54. *G. Nidus-avis* on *J. virginiana;* showing way in which the branch system is often distorted (from photograph by Shear).

Fig. 55. *G. Nidus-avis* on *J. virginiana;* showing character of telia on the larger branches.

Fig. 56. *G. exterum* on *J. virginiana;* telia applanate and anastomosing over surface of a fusiform swelling.

PLATE 158

Fig. 57. *G. clavariaeforme* on *J. sibirica;* telia mature but dry.

Fig. 58. *G. clavariaeforme* on *J. sibirica;* the same specimen a short time after spraying it with water.

PLATE 159

Fig. 59. *G. Betheli* on *J. scopulorum;* telia on irregular galls which break forth in succession, giving an elongated area of hypertrophy.

Fig. 60. *G. effusum* on *J. virginiana;* telia wedge-shaped and lacunose on a fusiform enlargement.

Fig. 61. *G. gracilens* on *J. utahensis;* telia cristiform, on a slight swelling.

PLATE 160

Fig. 62. *G. cornutum* on *J. communis;* from a European specimen. After Oersted (1866[1], *pl. 3. f. 2*).

Fig. 63. *G. cornutum* on *J. sibirica;* from an American specimen.

Fig. 64. *G. corniculans* on *J. horizontalis;* telia conic, on globoid galls originating in the twigs.

PLATE 161

Fig. 65. G. *Juniperi-virginianae* on *J. virginiana;* very young galls showing origin in a leaf.

Fig. 66. *G. Juniperi-virginianae* on *J. virginiana;* an older gall showing reniform shape but still showing no indication of telia. See *Pl. 151* (frontispiece) for a mature specimen with the cylindric-acuminate telia.

Fig. 67. *G. globosum* on *J. virginiana;* telia wedge-shaped, separated by the scars of the sori of previous seasons.

Fig. 68. *G. Nelsoni* on *J. utahensis;* telia thin, irregularly flattened, gall globoid and very hard and woody.

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